RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

Vol. 37 SEPTEMBER 1941 No. 3

Cholangiography, Fractional Method[1]

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SUFFICIENT TIME has elapsed to prove the value of cholangiography. Since 1918, when Reich (1) reported the case of a woman with a draining sinus in the mid-axillary line between the eleventh and twelfth ribs, in whom an injection of bismuth and petrolatum partially outlined the intrahepatic and extrahepatic biliary ducts, cholangiography has steadily advanced and improved both in its technic and value. The conventional method used was postoperative cholangiography which ranged from the courageous method of Burckhardt and Müller (2), who injected the gallbladder through the abdominal wall, to the more modern methods as initiated by Gabriel (3), and Ginzburg and Benjamin (4). The literature at this period was steadily increasing, lipiodol or an equivalent being used almost universally (5, 6, 7, 8, 9, 10, 11, 12, 13). Immediate cholangiography, the term used to define the procedure carried out in the operating room, was introduced by Mirizzi of Argentine in 1932 (14). He also used lipiodol, injecting through a T-tube which, of course, necessitates opening the common duct.

In 1936 Robins and Hermanson (15), and also Hicken, Best, and Hunt (16), described the procedure of immediate cholangiography in this country. Hicken and his associates employed lipiodine diluted with olive oil as the contrast agent. At first their experience with immediate cholangiography was limited, but in 1937 Hunt, Hicken, and Best (17) described the advantages of the procedure.

The solution was injected into the gallbladder, the cystic, or the common duct by means of a special short-bevel needle with a bead 5 mm. from the tip. Robins and Hermanson had used a 15- to 18-gauge angulated tonsil needle for injecting. They were apparently the first to suggest an aqueous solution in order to avoid the errors encountered because of the non-miscibility of oily solutions with the bile. At that time they employed hippuran. This, in itself, was a distinct and valuable improvement. Subsequent findings confirmed the contention of Hulten (18) that peristalsis of the common duct was not demonstrated by cholangiograms.

Cholangiography has proved of inestimable value and is used almost routinely at the Beth Israel Hospital, Boston, Mass., on patients in whom biliary surgery is necessary. In 1938 Mixter and Hermanson (19) in an evaluation of the procedure reported two errors among 39 cases of immediate cholangiography. The fractional method was introduced in 1938 for both immediate and postoperative cholangiography, resulting in a greater degree of di-

[1] From the Department of Radiology, Beth Israel Hospital, Boston, Mass. Read before the Radiological Society of North America, at the Twenty-sixth Annual Meeting, Cleveland, Ohio, Dec. 2–6, 1940.

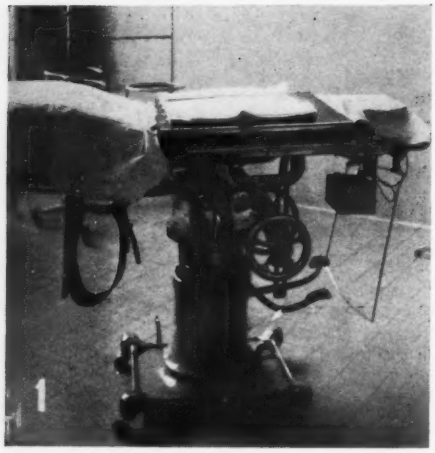


Fig. 1. Bucky diaphragm in position on operating table. Both ends of the table are built up with pillows to the level of the Bucky.

agnostic accuracy. The principle governing the employment of fractional amounts is the same as in gastro-intestinal roentgenology, cystography, uterotubography, etc. Water-miscible solutions are used and at present diodrast is the solution of choice.

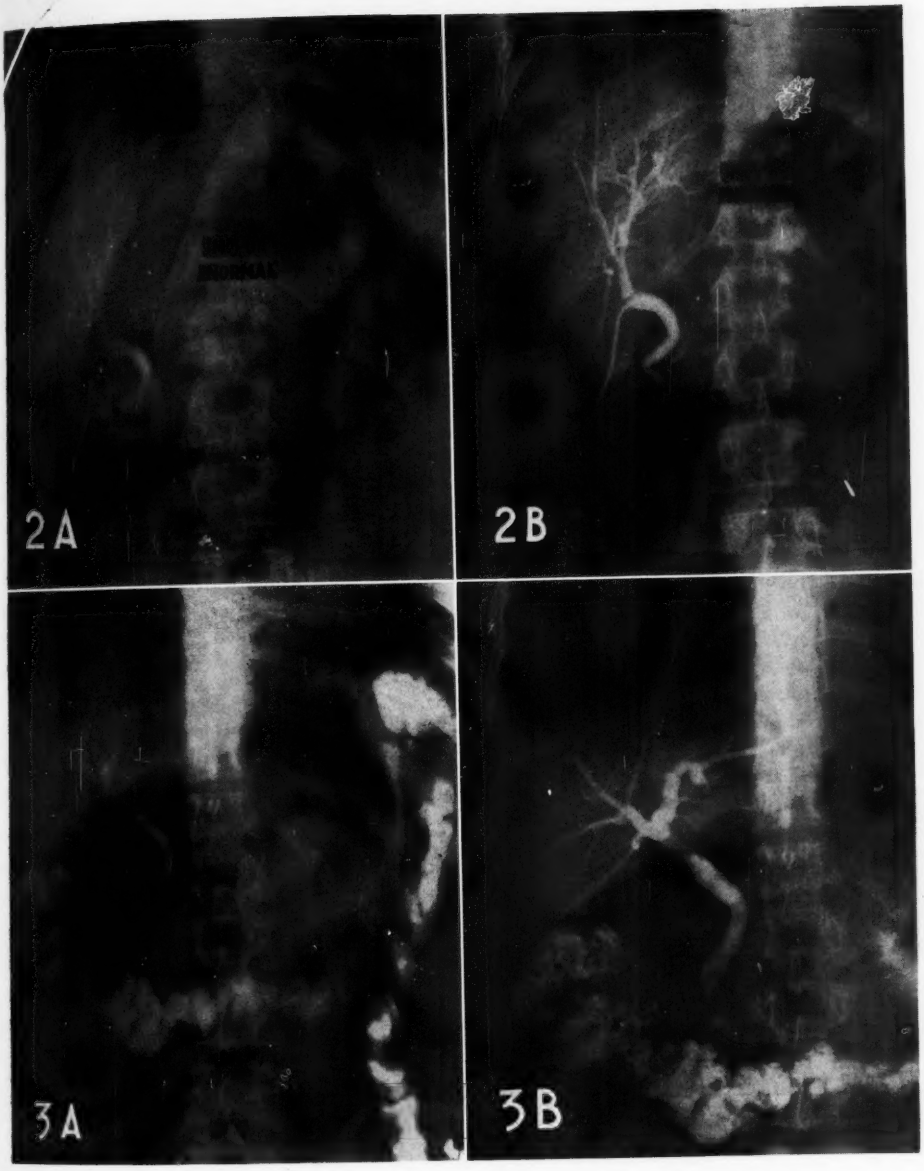
The technic used in the operating room is as follows: A flat Bucky diaphragm (Fig. 1) is placed on the operating table. The patient is put in position before the operation and a 14 × 17 loaded cassette is left in the Bucky tray. A bedside shockproof unit is used. The factors employed are: 80–90 kv., 30-in. distance, and 60 ma. seconds. Most patients have had spinal anesthesia. It is possible, therefore, to have respiration suspended voluntarily during the exposure.

At operation the cystic duct is exposed and through a small incision a ureteral catheter, size 6–8F, is introduced, pushed into the common duct, and tied in. (This method was introduced by Dr. Charles G. Mixter, surgeon in chief.) Bile is then aspirated through the catheter and its nature carefully noted. After aspiration of the bile, a small amount of diodrast is injected, from 3 to 5 c.c., depending on the size of the duct. A single film is then taken. An additional amount (8–10 c.c.) is now injected and a second film is taken. The surgeon continues with the operation while the films are being developed in a special dark room which is an integral part of the operating room suite. An interpretation of the film is returned within five or six minutes after the exposure. If the cholangiogram shows no pathology, and there is no indication for exploration of the common duct, additional films are unnecessary. If the common duct has been or is to be explored, a check-up film is taken before closing the abdomen.

Postoperative cholangiography is done in the X-ray Department. First, bile is aspirated through the inlying tube or catheter and then a small amount of diodrast (about 4 c.c.) is injected. At times it is advisable to flush the tube with saline preliminary to the instillation of the contrast medium. Larger amounts (about 6–10 c.c.) are then injected and stereoscopic films are taken. Following this, amyl nitrite is inhaled by the patient and a fourth film is taken as 4–5 c.c. more are injected. The amyl nitrite relaxes the sphincter of Oddi, resulting in better visualization of the intramural portion of the ampulla.

The fractional method has been of distinct aid in establishing a definite diagnosis where difficulties in interpretation have been encountered because of (1) motion caused by breathing (Figs. 2 and 3); (2) spill or leakage around the catheter or T-tube; (3) air bubbles (Fig. 4); (4) kinks in the cystic or common duct; (5) overlapping bone shadows (Fig. 5); (6) superimposed instruments, catheters, or T-tubes; (7) anomalies (usually congenital); (8) a tortuous and dilated cystic duct superimposed on part of the common duct; (9) artefacts. In many instances where a diagnosis of stone in the common duct is questionable, serial films, with the fractional method, will demonstrate pathology.

In viewing films after fractional amounts of dye had been injected it was generally found that the pathology was best shown in one (Fig. 7). Whether it would be the



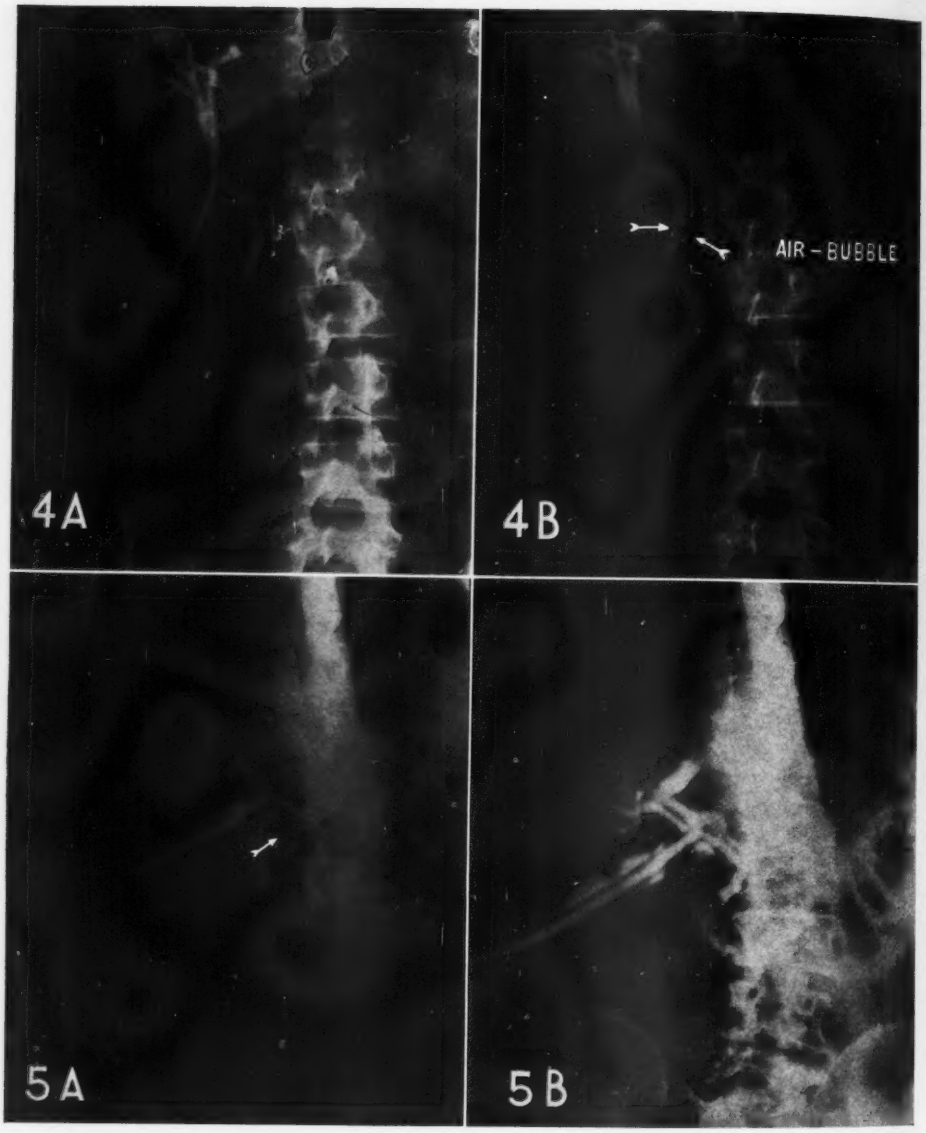
Figs. 2 and 3. Immediate cholangiograms in two cases (Fig. 2, R. Z.; Fig. 3, H. S.).

2 A. Small amount injected. Common duct well filled but motion makes the diagnosis uncertain Note the ureteral catheter.

2 B. Large amount injected. The common duct is well visualized and the intramural portion of the duodenum is seen. The pancreatic duct is also partially filled. The findings were normal and no stones were found at exploration of the common duct.

3 A. Small amount injected. Suggestive mottling at the distal end of common duct, but detail obscured by motion.

3 B. Large amount injected. No motion was present in this film and a diagnosis of detritus was made because of the filling defect at the distal end of the common duct. The diagnosis was confirmed at exploration of the duct.



Figs. 4 and 5. Postoperative cholangiograms in two cases (Fig. 4, F. G.; Fig. 5, M. M.).

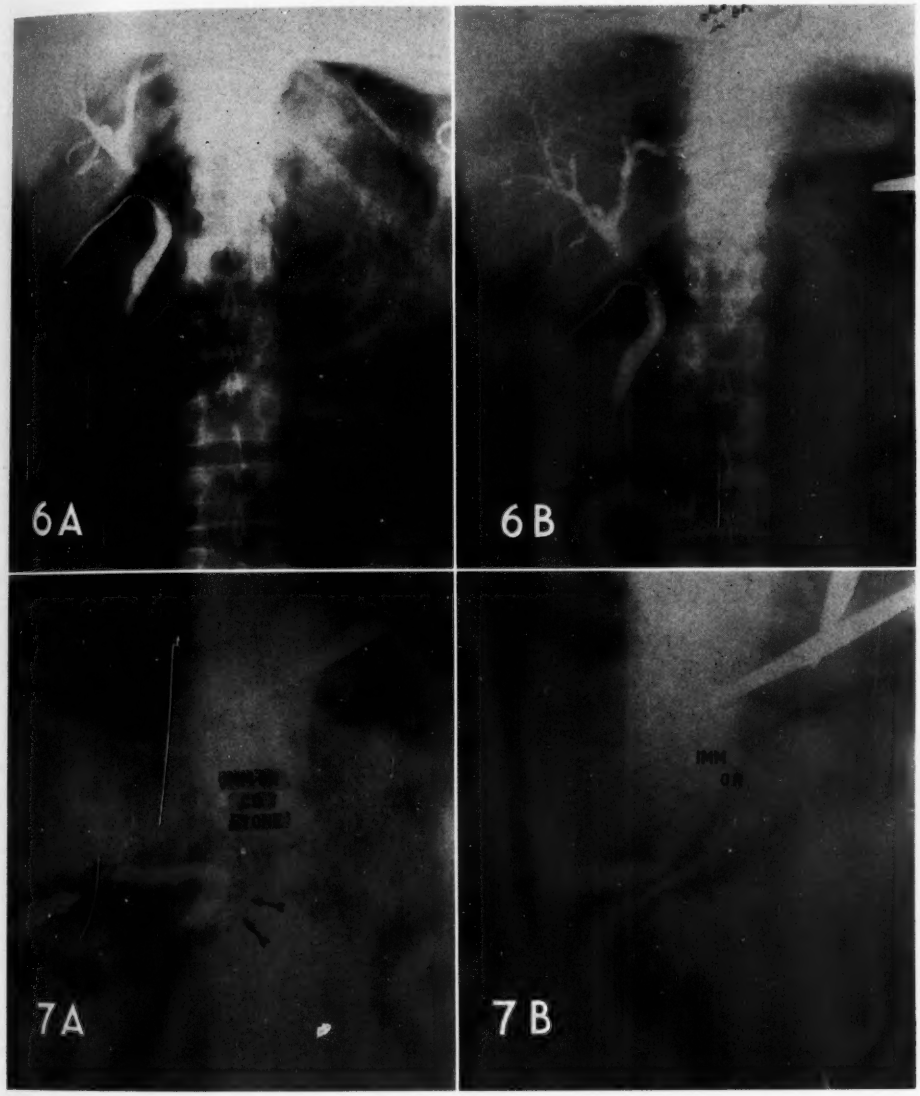
4 A. Small amount injected. Excellent visualization of the common duct and its intramural portion No pathology present.

4 B. Large amount injected. Defect (air bubble) present in common duct. Had this been the only film, a definite diagnosis would have been difficult.

5 A. Small amount injected. Apparent filling defect present near tip of T-tube.

5 B. Large amount injected. No filling defects seen and possibility of residual common duct stone ruled out. Close scrutiny of the film showed the suspicious shadow to be due to a superimposed transverse process.

film following injection of a larger or smaller amount could not be predetermined. In some cases the intramural portion of the ampulla was visualized only with the smaller amount, the larger amount precipitating spasm (Figs. 8 and 9). In other instances the reverse was true. Defects in the ducts caused by air



Figs. 6 and 7. Immediate cholangiograms in two cases (Fig. 6, A. B.; Fig. 7, M. L.).

6 A. Small amount injected. Common duct well filled but semilunar defect present at ampulla. No dye is seen in the duodenum.

6 B. Large amount injected. Defect still present at ampulla. Exploration of common duct revealed stones.

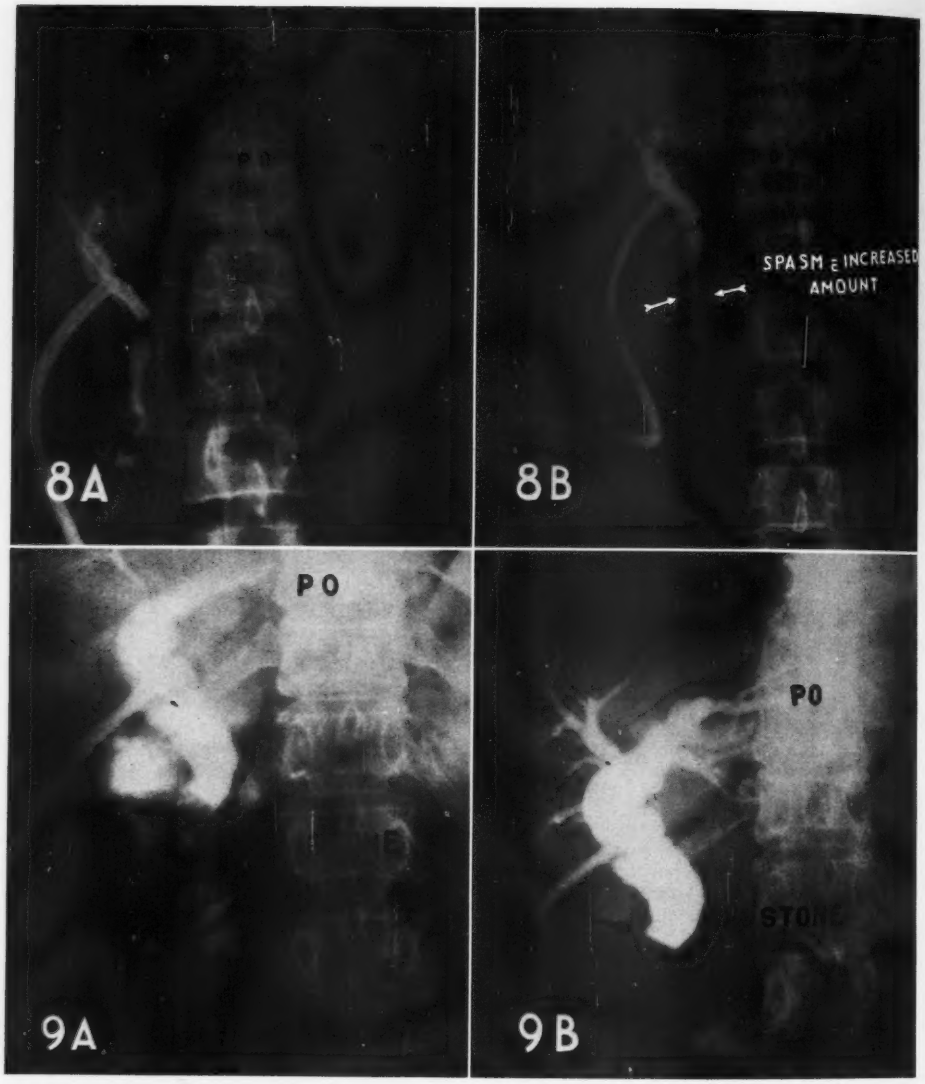
7 A. Small amount injected. Large stone present in mid-portion of common duct.

7 B. Large amount injected. Stone in common duct obscured by too much dye

introduced during the injection are difficult to differentiate from stones. The defects caused by stones, however, are generally constant in size and position while air bubbles change their position, shape, and size, and this can often be demonstrated when the fractional method is used (Figs. 4 and 10).

The 109 cases in which fractional cholangiography was done are divided into three groups:

1. In the first group, of 27 patients,



Figs. 8 and 9. Postoperative cholangiograms in two cases (Fig. 8, S. B.; Fig. 9, A. P.).

8 A. Small amount injected. Common duct well filled. Intramural portion of common duct very well outlined. No pathology present.

8 B. Large amount injected. Spasm of ampulla has been induced.

9 A. Small amount injected. Large stone present at ampulla. No dye present in hepatic radicles.

9 B. Large amount injected. Hepatic radicles well filled. Spasm of ampulla present so that stone is not demonstrated. Note, however, distance between end of common duct and the dye in the duodenum.

only immediate cholangiography was done. All these cases were diagnosed as normal and no further studies or explorations were done.

2. In the second group, of 35 patients, only postoperative cholangiograms were made. Immediate cholangiography was not done. Nine (25.7 per cent) showed the presence of common duct stones. This indicates the inadequacy of strictly surgical exploration of the common duct. Of the 9 patients, one refused a second

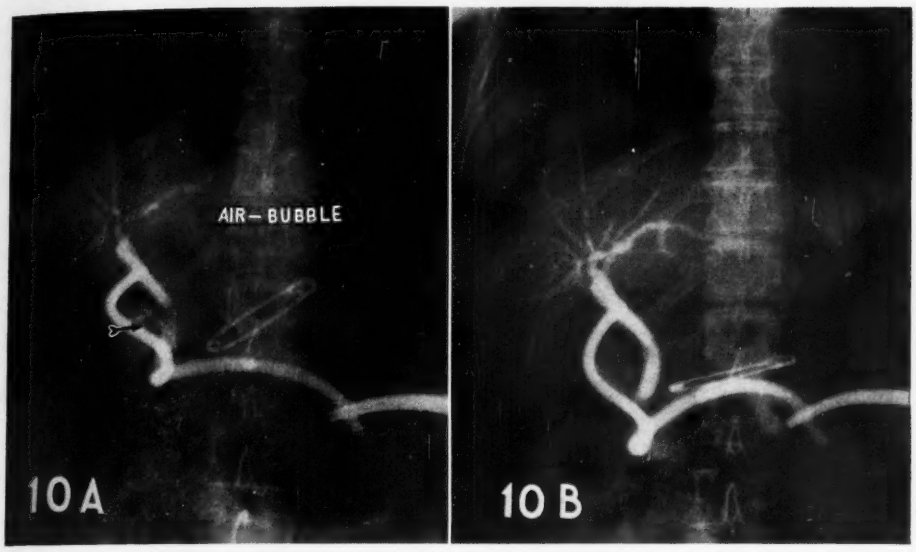


Fig. 10. Postoperative cholangiogram (S. F.).

10 A. Small amount injected. Distal portion of common duct obscured by T-tube. Filling defects in mid-portion of common duct.

10 B. Large amount injected. Common duct shows no pathology. Filling defects are not constant and are seen in the hepatic radicles. They are due to air bubbles.

operation. Three were again operated on and stones were found in all. One of the remaining patients, after a medical régime, passed the stone, as revealed by a cholangiogram. At the time of this report further surgery has not been done on the other 4 patients.

3. In the third group, 47 patients, immediate cholangiography was done in the operating room, followed by at least one postoperative cholangiogram. Out of this group of 47, there were 17 (36 per cent) who showed common duct stones. In 6 of these 17 the cholangiograms were technically unsatisfactory. (In 2 the catheter was pushed in too far, so that the tip was in the duodenum, 2 showed incomplete filling, and in 2 others the exposures were unsatisfactory.) Of the 11 others there were 3 in whom no cholangiogram was made before the stones were removed. Six of the remaining 8 showed stones, which were removed subsequently. Of the remaining 2, the findings in one (one of our very first cases) were misinterpreted as an air bubble. This was due to lack of experience. In only one case in which the technical factors were acceptable did the immediate cholangiogram fail to show a stone which was visible in the postoperative cholangiogram. The immediate cholangiogram in this case showed no dye in the duodenum and the intramural portion of the ampulla was not demonstrated. Exploration of the common duct revealed one facetted stone and detritus. Postoperative cholangiograms showed a shadow simulating an air bubble. It was constant on two examinations so that the presumptive diagnosis was common duct stone.

The incidence of common duct stones in the entire group was equivalent to 30.3 per cent in which the diagnosis was proved at operation and 33 per cent in which common duct stones were seen at operation or diagnosed by cholangiography. These figures are higher than those quoted by Lahey (20) and Payne (21) but approximate those of Allen and Wallace (22).

In 22 per cent of the cases of this series fractional cholangiography, as compared

to ordinary cholangiography, did not further aid the diagnosis. In 78 per cent, however, the fractional method was of distinct and additional value.

The mortality rate in this series was less than 1 per cent. A single death occurred. A man seventy years of age who had an acute, partially gangrenous gallbladder died three days after operation with acute renal failure. In view of this, it can be definitely stated that the procedure entails no added risk.

CONCLUSIONS

The fractional method of cholangiography lessens the percentage of diagnostic errors. It simplifies diagnosis when by a single film the diagnosis would be difficult because of (1) motion; (2) spill or leakage around the catheter or T-tube; (3) air bubbles; (4) kinks in the cystic or common ducts; (5) overlapping bone shadows; (6) superimposition of the cystic duct on the common duct; (7) superimposed instruments, catheters, or T-tubes; (8) anomalies; (9) artefacts.

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Gastrocolic Fistula: Report of Twelve Cases[1]

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GASTROCOLIC fistula is a comparatively uncommon condition. Despite its rarity, it is a lesion of unusual interest and of great importance to the clinician, roentgenologist, and surgeon. Clinically, it is important because the presence of a communication between the stomach and colon produces a short-circuiting of the entire small intestine and the proximal portion of the colon. This interferes with the patient's nourishment so seriously that it usually results fatally in a relatively short time. Immediate, accurate diagnosis is essential if there is to be any hope of effecting a cure. In arriving at the diagnosis, the roentgen examination occupies a position of highest importance. While the possibility of a gastrocolic fistula may be suspected and may occasionally be diagnosed presumptively on the clinical facts, there is no certain way of proving the diagnosis prior to operation except by the roentgen observations. These studies serve also to demonstrate the site of the lesion, the exact portions of the viscera affected, and, in many instances, the underlying cause. Since prompt operative interference usually offers the only possible hope of relief, the surgeon is particularly desirous of establishing the diagnosis as early as possible so that operation may be performed before the patient's condition becomes too poor to withstand surgical measures.

ETIOLOGY

There are many causative factors in gastrocolic fistula among which the following may be mentioned as the more important: peptic or jejunal ulcer, cancer of the stomach, cancer of the colon, severe abdominal trauma, stab or gunshot wounds, abdominal abscess, syphilis, pancreatic tumors, retroperitoneal sarcoma, tuberculosis, and peritoneal adhesions. It may also occur as a postoperative complication.

The most common causes are the first three mentioned above: peptic ulcer, cancer of the stomach, and carcinoma of the colon. In our series of 12 cases collected from the records of the Boston City Hospital, 7 were subsequent to posterior gastro-enterostomy, 3 were associated with carcinoma of the stomach, 1 resulted from malignant neoplasm of the colon, and 1 probably from a neoplasm of undetermined origin. The literature mentions congenital defects as an important etiological factor. There is, however, no embryological or developmental basis for this anomaly. Although intra-uterine infection is possible, it is very rare and it appears extremely unlikely that it can produce this lesion.

The incidence of the condition is doubtless distinctly greater than the number of recorded cases would lead one to believe. There are two important reasons which account for this discrepancy. First, many cases are never reported in the literature, gastrocolic fistula being so rare that most clinics do not have a sufficient number of examples to make it appear worth while to record their observations. Secondly, many patients have in the past died as a result of this lesion without the correct diagnosis having ever been made.

Gastrocolic fistula is more common in males, only relatively few of the cases having been in females. Of the 12 examples herein reported from the records of the Boston City Hospital, 11 were in men. The age incidence reveals a very wide variance as would be expected from the variety of etiological factors enumerated above. The later decades of life show the highest incidence. In our series, the ages ranged

[1] Read before the Radiological Society of North America, at the Twenty-sixth Annual Meeting, Cleveland, Ohio, Dec. 2–6, 1940.

from thirty-four to seventy years, with an average of fifty years.

Fistulas resulting from carcinoma of the stomach and colon have in recent years shown a progressive decrease in number and are now relatively rare. This is due to earlier, more accurate diagnosis and improvement in the surgical attack on these lesions. On the contrary, it is unfortunately a fact that gastrocolic fistulas associated with peptic and jejunal ulcer have definitely and progressively increased. This is because of the large number of posterior gastro-enterostomies which have been performed. Anatomically, the mesocolon is anterior to the descending loop of the jejunum. If at the time of performing the anastomosis between the stomach and jejunum, the surgeon places the sutures joining the stomach to the mesocolon improperly, the colon may be brought into close contact with the stoma. As a result, adhesions form which predispose to perforation and fistula formation.

PATHOLOGY

The perforation which brings about the gastrocolic fistula is in rare instances acute. In that case there may develop adhesions, depending on the extent of the peritoneal reaction. More commonly, however, the perforation is of a low-grade, chronic type with resultant organization. The adjacent viscera are bound together and there is walling-off of the area of inflammation as nature attempts to localize the infection. If the walling-off process fails, the perforation usually results in the formation of a localized abscess cavity rather than in a general peritonitis.

The adhesions, inflammatory reaction, and contracture of scar tissue in and about the area involved at times cause marked displacement and distortion of the adjacent viscera. The efferent loops of jejunum are likely to show thickening, dilatation, and hypertrophy. The colon may be markedly narrowed at the point of opening of the fistula, in which case considerable distention of the bowel occurs proximal to the lesion. In some cases this masks the true pathology by superimposing the picture of intestinal obstruction. Rarely, the stenosis of the colon becomes so marked that cecostomy, colectomy, or some other similar procedure is required for relief of the obstruction. Multiple fistulas may be observed in rare instances, although the opening is usually single.

The communication between the stomach and colon is of two types, direct and indirect. In the direct variety, the stomach and colon are in close contact with each other at the site of the lesion, and the opening between the two viscera is wide and large, with smooth edges. In fistulas resulting from carcinoma of the stomach or colon, the communication is usually lined with cells similar to those found in the neoplasm itself. The indirect type of gastrocolic fistula frequently presents a tract which is long, narrow, and irregular. The communication most commonly occurs between the greater curvature side of the stomach and the transverse portion of the colon or the descending colon distal to the splenic flexure.

SYMPTOMS

The symptoms are in many cases those of the primary condition, that is, the preexisting peptic ulcer, cancer of the stomach, or malignant neoplasm of the colon. There may then occur a sudden, acute episode when the fistula develops. If the perforation is of the gradual, slow type there results a change in symptomatology which varies from slight to marked, depending on the character of the lesion. The acute onset is rare and may be characterized by sudden prostration and massive hemorrhage as the first manifestations of the condition. Cramps, diarrhea, and fecal vomiting occasionally herald the sudden formation of the fistula. The lesion may eventuate at any time from a few weeks to several years after posterior gastro-enterostomy. Therefore, any acute episode with sudden, marked change in symptomatology after this operation must be viewed with the greatest suspicion and

should immediately bring to mind the possibility of gastrocolic fistula.

Most commonly by far, the onset is insidious and gradual rather than sudden and acute. Loss of weight, nausea, diarrhea, and fecal vomiting are the important clinical symptoms. The weight loss is marked and continues rapidly despite the fact that the appetite is good and the food intake large. Weakness and dehydration develop since the ingested food is short-circuited directly from the stomach into the colon, with evacuation from the body before absorption can take place. Nausea is absent in some instances but is frequently severe, accompanied by belching and vomiting. The eructations are foul, gaseous, and disagreeable not only to others but to the patient himself. There may be regurgitation of fecal material. Belching is apt to be present when vomiting is absent and at times precedes the onset of the vomiting spells by a few days. Gastric lavage does not prevent the eructations, and enemata usually bring about increase of the belching. Medication administered rectally may be tasted by the patient. Fecal vomiting is, in the absence of intestinal obstruction, pathognomonic of this lesion. The vomitus often closely resembles the diarrheic stools; it is decreased by the ingestion of solid foods and gastric lavage and increased by enemas. Vomiting is intermittent, tending to increase when diarrhea is considerable and ceasing if constipation develops.

Diarrhea is the most constant and consequently among the most important symptoms. It is often the first complaint and may be either persistent or intermittent. The movements are frequent, numbering ten, twelve, or more daily with watery, yellowish, fatty stools. They most commonly occur soon after meals and contain recently ingested, unchanged particles. The movements may come two to three hours after meals and during the night. The stools are strong, foul in odor, and acid because of the presence of gastric secretions or fatty acids. Fat in the stools is an important finding. Medication usually does not influence the diarrhea. Pain is rarely noted and tends to be variable and inconstant; if present, it may lessen as the diarrhea increases. In the presence of an active gastric or jejunal ulcer, the pain occurs in the epigastrium or to the left of the umbilicus. With secondary stricture of the colon, as described above, there may be intermittent colic, occasionally severe.

The symptoms are rarely periodic and chronic, persisting over a period of many months or years with intervening periods of relative well-being. More commonly, however, the course is continuous and rapidly progressive with a swift decline in the patient's condition. If surgical relief is not obtained, the patient goes speedily down hill and death soon ensues. The prognosis is usually grave, although in the exceptional case with an intermittent or ball-valve type of obstruction remissions may occur, with survival for many months or years.

PHYSICAL SIGNS

The physical findings are variable, unreliable, and relatively unimportant in arriving at a diagnosis. Rarely, adhesions result in the formation of a mass, which is misleading rather than helpful diagnostically. Similarly, intestinal obstruction sometimes occurs and obscures the picture. Tenderness is seldom present.

The marked weight loss, wasting, and dehydration are the striking features. The feces contain fat, undigested food, free hydrochloric acid, fatty acids, and muscle fibers. The administration of a meal containing colored substances results in similar matter soon appearing in the stools. Study of the gastric contents may reveal fecal material. Gastric lavage directly after an enema demonstrates the presence of the injected fluid in the stomach. The diagnosis may be suspected or made on the basis of the following important symptoms and signs: a sudden change in or exacerbation of symptoms after posterior gastro-enterostomy; marked wasting and rapid weight loss without

other demonstrable cause; fecal eructations and vomiting in the absence of intestinal obstruction; severe diarrhea with undigested food, hydrochloric acid, and muscle fibers in the stools; colored foods excreted rapidly in the stools; colored enemata appearing in the gastric contents or vomitus.

ROENTGEN FINDINGS

The pathognomonic roentgen finding is the demonstration of the abnormal communication between the colon and the stomach. On the administration of a barium meal, the opaque material may be seen to pass directly into the colon. Or in giving a barium enema, the stomach, duodenum, and jejunum are observed to fill simultaneously. The opaque mixture usually appears in the stomach and small intestine before the colon is completely visualized. There is no rule as to whether the barium meal or the opaque enema examination is the more dependable means of demonstrating the lesion. In some instances, the oral method is better, whereas in others only the injection route reveals the fistula. Repeated studies with careful palpation and "spot films" made under fluoroscopic guidance are essential in all suspected cases, as several examinations may be required to demonstrate the lesion. If the communication is small it is very easily overlooked. With an extensive tract intervening between the stomach and colon, a perforating ulcer or diverticulum formation may be erroneously diagnosed.

If the lesion is due to carcinoma, irregularity of outline, filling defects, and narrowing of the lumen of the involved viscera may be demonstrable. A crater or niche may be present in case of ulcer. Limitation of mobility of the stomach, colon, or both may occur. The presence of barium in the distal portion of the transverse colon and in the descending colon with none or but very little of the opaque mixture visible in the cecum, ascending colon, and the proximal portion of the transverse colon, should arouse suspicion in the mind of the observer and lead to the making of a careful and thorough search for fistula formation. Inflation of the colon with air may demonstrate unusual gaseous distention of the stomach.

TREATMENT

Prophylaxis is of the utmost importance. After a posterior gastro-enterostomy, thorough ulcer therapy is indicated with diet, alkalis, and other routine medical measures. Prior to operation for relief of a gastrocolic fistula, forcing food should be attempted. Fluids should be administered orally, rectally, and by injection methods. Transfusions are given if indicated. Vitamin lack and loss of minerals and proteins must be compensated for if possible. If the patient's condition precludes surgery, every attempt must be made to bring about improvement by the above and other appropriate measures. Operation is indicated as soon as the diagnosis is made and the patient's condition warrants intervention. The details of the surgical attack on this lesion are not within the scope of this discussion.

It is important to emphasize that gastrocolic fistula seldom if ever occurs after gastric operations other than gastro-enterostomy. This possibility constitutes a very important contraindication to the procedure, which has been so widely used in recent years. It is now quite generally accepted that gastro-enterostomy should be done only in carefully selected cases where for important reasons other, more satisfactory types of operation cannot be performed.

CASE REPORTS

CASE 1: J. R., male, age 34 (Boston City Hospital, vol. 1369, p. 120), entered the hospital complaining of diarrhea, vomiting, and epigastric pain. Five years previously he had a posterior gastro-enterostomy for peptic ulcer and continued well until nine months before entry. He had lost 45 pounds in the past year and had a productive cough and night sweats. Since the onset, nine months ago, there had been almost continuous watery diarrhea. There was no blood in the stools at any time.

The scar of the previous operation was well healed. There was no distention, visible peristalsis,

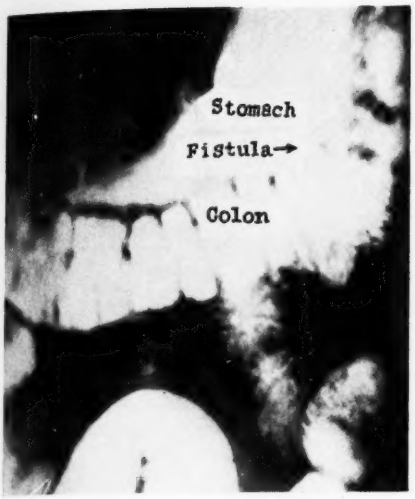

Fig. 1. Case 5: Gastrocolic fistula after posterior gastro-enterostomy. During the examination of the colon by the opaque enema, the stomach was observed to fill.

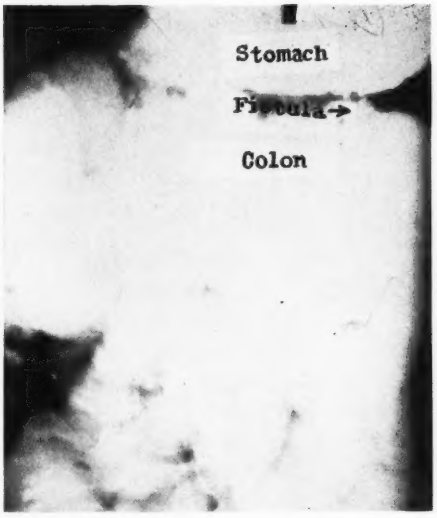

Fig. 2. Case 7: Gastrocolic fistula subsequent to posterior gastro-enterostomy. The examination of the colon with the opaque enema revealed simultaneous filling of the stomach *via* the communication between the transverse colon and the greater curvature side of the stomach. The visualization of the stomach prior to the complete filling of the colon is well demonstrated on this film.

or mass in the abdomen. The roentgen studies revealed a gastrocolic fistula. The patient failed rapidly and died five days after admission.

CASE 2: L. L., female, age 47 (Boston City Hospital, No. D166, p. 388), gave a long history of peptic ulcer with pain relieved by food and soda, the symptoms having been persistent for about fifteen years. Three months prior to admission, she had been operated on and an obstructive lesion was found at the pylorus. Shortly after operation, she began to have severe vomiting; the vomitus was brownish and fecal in odor. On admission she was very weak and markedly emaciated.

Roentgen studies revealed a probable fistula between the stomach and transverse colon. Operation was performed and it was found that there was an anastomosis between the prepyloric portion of the stomach and the large bowel. No ulcer was demonstrable. Both ends of the stoma were inverted and closed. The patient reacted poorly after the operation and death ensued.

CASE 3: J. O'B., male, age 55 (Boston City Hospital, No. E432, p. 252), had been operated on, about ten years prior to admission, for a perforated gastric ulcer. One year later, because of persistent abdominal pain, a posterior gastro-enterostomy was performed. For the past three or four years the patient's health had been failing gradually. There was no pain but a continuous feeling of distress with frequent belching. Diarrhea had been present for several days before entry to the hospital.

On admission the patient was markedly emaciated and appeared to have been chronically ill for a considerable period of time. There was no abdominal spasm, rigidity, or tenderness and no masses were palpable. Roentgen studies revealed a large prepyloric lesion, probably an ulcer, and a gastrocolic fistula involving the greater curvature side of the stomach and mid-transverse colon.

The diarrhea could not be controlled and the patient vomited and frequently belched fecal smelling material. At operation, a gastrocolic fistula was found. Three inches of the jejunum were resected, an end-to-end jejunal anastomosis was done, the openings into the stomach and the colon were closed, and a jejunostomy was performed. The patient failed to rally and died of shock the following day.

CASE 4: B. G., male, age 58 (Boston City Hospital, No. 807,600), was operated on eighteen years ago for a perforated peptic ulcer and again six months later for pyloric obstruction. Two years subsequently, he had an operation for jejunal ulcer and a year after this was operated on for relief of a gastrocolic fistula. Thereafter he did well for sixteen years. During the six weeks prior to admission, he had a dull, aching pain in the left side. Physical examination showed an indefinite mass in the left upper quadrant; otherwise no abnormalities were noted.

Roentgen studies revealed a functioning posterior gastro-enterostomy with marked narrowing of the proximal loop of jejunum at a point about 12 cm. from the stoma. At operation, the gastro-enterostomy was excised and an end-to-side anastomosis performed between the blind end of the stomach

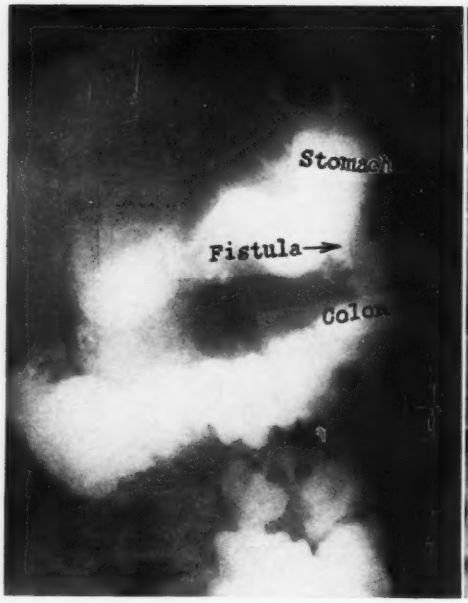

Fig. 3. Case 8: Gastrocolic fistula due to gastric carcinoma. There is a broad, irregular communication between the stomach and colon. The fistula was demonstrated during opaque meal examination of the stomach.

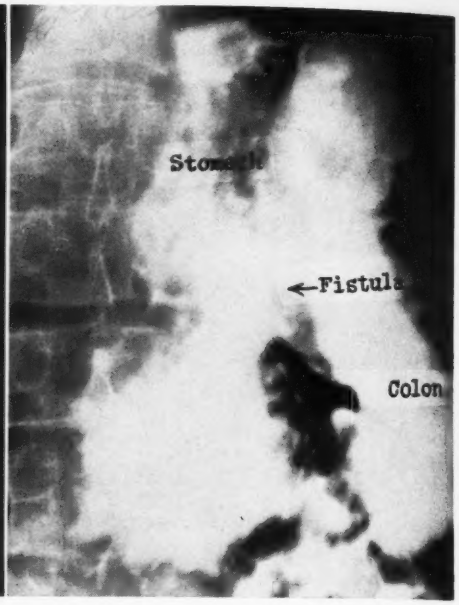

Fig. 4. Case 9: Gastrocolic fistula associated with carcinoma of the stomach. The fistula involved the greater curvature side of the stomach and the distal portion of the transverse colon.

and the free end of the jejunum. The patient died of pneumonia subsequent to operation. Postmortem studies showed diffuse peritonitis, gastroduodenostomy, old scars in the wall of the stomach and colon. There was no evidence of malignancy.

CASE 5: J. C., male, age 49 (Boston City Hospital, No. 957,586), was operated on about five years ago for a duodenal ulcer, a posterior gastroenterostomy being performed. He did very well until a few months ago, when he began having epigastric pain and diarrhea. There were no bloody stools; he had vomited a few times. Physical examination revealed marked emaciation and weakness. No masses were felt and there was no abdominal tenderness on palpation.

Roentgen studies by the opaque meal method revealed a posterior gastro-enterostomy and an old duodenal ulcer; barium enema examination demonstrated a gastrocolic fistula involving the mid portion of the transverse colon and stomach (Fig. 1).

The transverse colon was resected and an ileosigmoidostomy performed. About ten weeks later, a subtotal gastric resection was carried out with a block resection of the fistula. The patient was discharged improved.

CASE 6: J. C., male, age 42 (Boston City Hospital, No. 811,702), had a posterior gastro-enterostomy for ulcer fourteen years previously. He progressed satisfactorily with diet and medical care until about four months before the present admission, at which time he began to have severe vomiting and pain. Marked weakness and emaciation developed. Gastro-intestinal roentgen studies demonstrated a gastrocolic fistula. The patient failed to respond to medical therapy and died.

CASE 7: H. C., male, age 36 (Boston City Hospital, No. 922,425), began to have gastric complaints seven years before, and four years later was operated on for a bleeding ulcer. After the operation, he had recurrent hemorrhages and periodic ulcer symptoms. Two years ago, gastro-intestinal roentgen studies revealed a prepyloric ulcer, a functioning posterior gastro-enterostomy, and a probable jejunal ulcer. At the final admission, a barium enema examination demonstrated a gastrocolic fistula (Fig. 2). Operation was performed and the patient died shortly thereafter.

CASE 8: G. K., male, age 44 (Boston City Hospital, B1594, p. 64), entered the hospital complaining of vague pain of one year's duration, in the left upper quadrant. An indefinite mass was felt in this region. Gastro-intestinal series revealed no abnormalities. Persistent abdominal pain developed about one month ago. Physical examination at the time of the last admission showed a large, firm, non-tender mass in the left upper abdomen. Re-examination of the stomach with an opaque meal demonstrated a gastrocolic fistula secondary to an

extensive carcinoma of the stomach (Fig. 3). At operation, a mass the size of an egg was found involving the stomach, transverse colon, and liver. The patient died postoperatively. Postmortem studies revealed a generalized peritonitis, carcinoma of the stomach with metastases to the lymph nodes and liver, and a gastrocolic fistula (Fig. 3).

CASE 9: R. McD., male, age 60 (Boston City Hospital A38, p. 152), had been well until three or four months previously, when he began to have a dull, epigastric pain and gaseous eructations. His appetite became poor and for the past six weeks he had had severe diarrhea with six to eight movements daily. The stools were bloody and tarry. He had lost forty pounds in six months. Physical examination was negative except for the marked emaciation. Roentgen studies revealed a carcinoma of the stomach and a gastrocolic fistula (Fig. 4). At operation, a large mass was found extending between the stomach and transverse colon. Partial gastrectomy and colectomy were performed. The patient died a few days after the operation. Postmortem studies demonstrated a scirrhous carcinoma of the stomach with invasion and extension through the walls of the transverse colon.

CASE 10: J. D., male, age 70 (Boston City Hospital, No. 1,002,877), had felt entirely well until six months prior to entry, when he noticed that he was losing weight. He had lost a total of 45 pounds since then. About three months before admission he noticed a lump in the epigastrium and there had been a dull pain and dragging sensations in this region especially at night and while lying on the right side. His appetite had decreased markedly and there were occasional sour eructations. Three or four days before coming to the hospital he became nauseated and vomited coffee-ground material several times. The color of the stools remained normal and there had been no diarrhea except on one occasion about three days prior to admission.

On physical examination, a large mass was easily palpable in the left upper quadrant. The tumor felt firm and irregular and it moved only very slightly with respiration. The liver and spleen were not palpable. There were two small nodes along the border of the left sternocleidomastoid muscle. The patient was markedly emaciated.

At operation, an extensive gastric carcinoma was found with a fistula from the greater curvature side of the stomach communicating with the transverse colon. The patient died the day following operation.

CASE 11: C. U., male, age 53 (Boston City Hospital, No. 960,519), had been well until six months ago, when he had a sudden attack of nausea and vomiting with the passage of gas through the mouth and rectum. The symptoms improved somewhat until two months ago, when pain developed in the left flank, recurring almost daily. Beginning one month ago, there had been recurrent nausea and vomiting once or twice daily. There had been no gross blood in the stools.

Fig. 5. Case 11: Gastrocolic fistula due to carcinoma of the colon in the region of the splenic flexure.

The patient appeared undernourished and chronically ill. There was tenderness in the left flank and a firm mass under the costal margin. Routine gastro-intestinal roentgen studies showed no evidence of a fistula; barium enema examination, however, demonstrated a neoplasm at the splenic flexure and a gastrocolic fistula (Fig. 5).

At operation, a large infiltrating tumor was found in the left upper quadrant, with involvement of the stomach, the distal transverse colon, and the descending colon in the region of the splenic flexure. The tumor was inoperable. A specimen was removed for diagnosis and showed colloid adenocarcinoma of the splenic flexure with extension into the stomach and gastrocolic fistula formation.

CASE 12: R. T., male, age 52 (Boston City Hospital, No. 780,024), entered the hospital complaining of diarrhea of six months' duration. He had had frequent bowel movements averaging six or seven daily and four or five nightly and had lost seven pounds in weight. He had vomited fecal smelling material on two occasions during the past week. There were no tarry stools. The abdomen was slightly distended; no masses were felt and there was no tenderness or spasm.

Gastro-intestinal studies revealed a gastrocolic fistula. The lesion was demonstrable on both the barium enema examination and with the routine opaque meal and involved the prepyloric portion of the stomach and the transverse colon adjacent to the hepatic flexure. The patient went rapidly down hill and died without operation. The cause

of the fistula was not determined, although the clinical evidence pointed to a lesion secondary to carcinoma of the colon or stomach, more probably the latter.

SUMMARY

Gastrocolic fistula may result from a wide variety of causes but is most frequently seen following posterior gastroenterostomy, cancer of the stomach, and malignant disease of the colon.

Although it is a comparatively rare condition, the incidence is greater than the number of recorded cases indicates.

The important clinical symptoms are rapid loss of weight, nausea, diarrhea, and fecal vomiting. Definite clinical diagnosis, however, is usually not possible.

The pathognomonic sign of gastrocolic fistula is the roentgen demonstration of the abnormal communication between the stomach and colon.

The opaque meal may demonstrate the fistula in some instances; in other cases the barium enema examination reveals the lesion.

The mortality in gastrocolic fistula is very high and if surgical relief is not obtained promptly the patient goes speedily down hill and death soon ensues in a large proportion of cases.

Twelve cases from the records of the Boston City Hospital are herein reported.

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Study of the Gastro-Intestinal Tract of Children and Its Relation to the Adult[1]

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THE LITERATURE concerning the gastro-intestinal tract of the infant and young child contains the essential facts as to anatomy, physiology, and pathology, but many times the desired information is hidden under an indefinite title. Adequate studies and experiments have been made. One of the best articles, especially for radiologists, is that by Bouslog and his co-workers. The infant stomach was previously considered by Carman and LeWald. LeWald's text, however, deals mostly with disease conditions. It will be observed in a review of the literature that the investigations are usually upon infants or quite young children. Information concerning the gastro-intestinal tract of the older child and young adult is almost altogether lacking.

Studies of the adult gastro-intestinal tract fill the medical journals and texts dealing with the subject. This literature is much more complete than that of the infant and young child, evidently due to the greater urgency for the investigation of diseases of the adult. In general these diseases are studied as end-results; the anatomical changes are noted, the pathological conditions described, and the etiology often stated as obscure.

I have been unable to find any definite attempt to correlate the anatomy, physiology, and pathology of the digestive tract of the infant with that of the young child and the adult. The studies that have been made have considered these different age periods as separate groups and have disregarded the fact that one group gradually merges into another. This paper undertakes to begin such a correlation and to point out the opportunities for further study of the gastro-intestinal tract.

[1] Read before the Radiological Society of North America, at the Twenty-sixth Annual Meeting, Cleveland, Ohio, Dec. 2–6, 1940.

MOTILITY

There are several different kinds of motion in the digestive tract well described in the literature under the general heading of motility. The one which differs particularly in different age groups is that phase of physiology known as the transportation of food through the gastro-intestinal canal. There is fairly uniform agreement as to the time involved in the passage

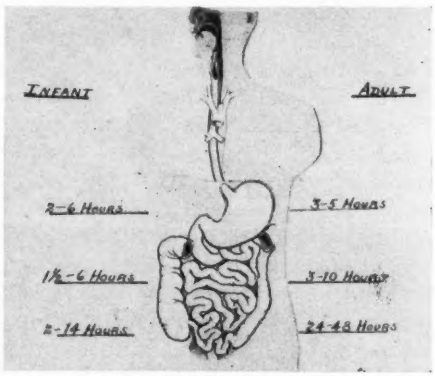

Fig. 1. Time-table for transportation of food through the gastro-intestinal tract of the infant and the adult.

of food through the stomach and various portions of the intestines in both the infant and the adult. It will be noted that in the infant there is a steady movement of food through the stomach, small intestine, and colon, without any definite point of delay except in the stomach. The stomach is the only portion of the gastro-intestinal tract constructed to be a reservoir, and, as just stated, is the only portion of the tract in the infant which shows a definite delay in food transportation.

The time involved in food transportation through the gastro-intestinal tract of the adult is quite different. The stomach and the small intestine empty in approximately

the same time interval as in the infant and young child; the great delay occurs in the colon. In the adult the emptying of the colon may require twenty-four to forty-eight hours longer than in the infant, and yet the anatomy of the colon is not primarily constructed for such a long delay in emptying. This slowing up of the transportation may, and usually does, begin in the young child. By the time the child is a few years of age the emptying time of the colon may closely approximate that of the adult.

ANATOMY

All investigators describe the gastro-intestinal tract of the infant as being made up of delicate structures. The mucous membrane throughout is quite delicate and quite vascular. The muscular layers are not well developed and this is also true, in general, of the sphincters. In the span of years from infancy to childhood and adult life there is a progressive change in the shape of most of the portions of the gastro-intestinal tract. The sphincters become more vigorous in their action. The contractions of the stomach and intestines are stronger, and the flexures are sharper in their angulations. There is a change in position of some of the organs, from the recumbent to the upright. There is likewise some localized enlargement, as in the first portion of the duodenum and the cecum.

As a result of many factors the transportation of food is slowed up particularly in the large colon and to a lesser extent in the small intestine. As a consequence the roentgenogram shows a different pattern in the adult than in the infant. This is particularly true of the small intestine. The upper portions of the small intestine of the infant lose their irregular globular pattern and assume the typical snow-flake appearance of the adult. The outline of the colon becomes much sharper, with a more complete filling and more pronounced haustral markings.

The increased sphincter control and changes in reflexes must be very important factors in the change of the rate of food transportation from the infant to the adult. If a colostomy is performed upon an adult, thereby removing the sphincter control of the rectum, the rate of transportation will usually revert to the infant type. A roentgenogram may show perfect position of the large intestine with a high transverse colon and excellent hepatic and splenic flexures, and yet forty-eight hours may be required for emptying this colon. The appendix of the infant and young child is seldom visualized, but in the examination of the adult such a lack of visualization upon the roentgenogram is frequently considered as evidence of occlusion and disease of the appendix.

DISEASE

In a comparison of a list of diseases of the gastro-intestinal tract seen in a children's hospital with that of a general hospital, a marked difference is noted. Diseases of infants and young children are mostly those that can be attributed to functional disorders: pylorospasm, foreign bodies, occasional disease of the appendix, anomalies, acute infections of the colon, intestinal intussusception, etc. An ulcer of the duodenum in an infant or young child is extremely rare; an ulcer of the stomach is found only in several hundred autopsies. Diverticula are occasionally observed but diverticulitis is very unusual. On the other hand, the diseases of the adult are ulcers, carcinomas, diverticulitis, and obstruction—a list well know to every physician. In other words, they are diseases resulting from long years of life and the incidents associated with living. Again I wish to point out that this list of diseases is quite different from those found in the infant and young child.

As stated above, the gastro-intestinal tract of the child and young adult has not received the same study as that of the infant and the older adult. There are probably several reasons for this, but one which I wish to point out is that the children and young adults of this age group are usually in the period of best health. Their diseases are very often of a functional type

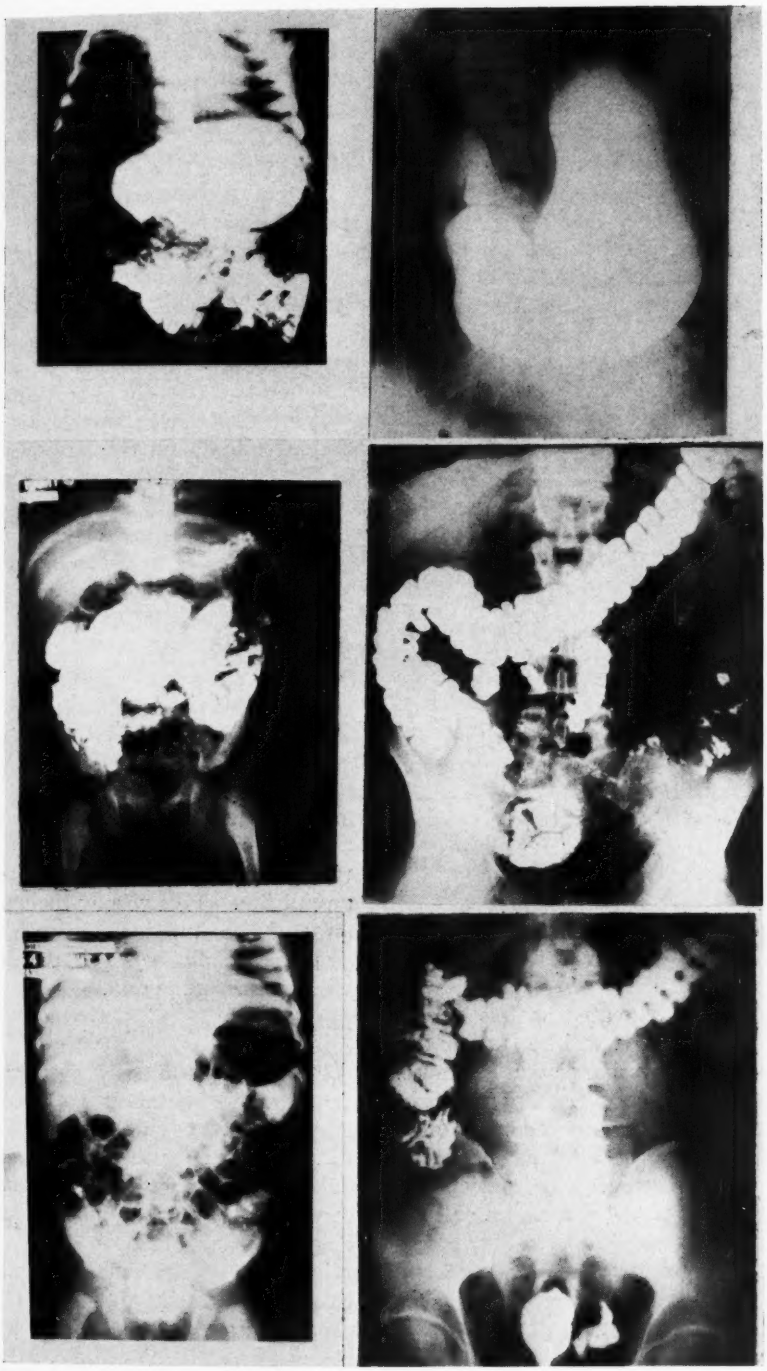

Fig. 2. Comparative films of the infant and adult gastro-intestinal tract (infant four and a half months; adult forty years). Stomachs taken immediately; small intestines at five hours; colons at twenty-four hours.

and usually overlooked by both parents and doctors. The findings from clinical or roentgen examination are difficult to evaluate and perhaps even more difficult to treat. If in the child or young adult the gastro-intestinal tract is in a good physiological state, with adequate elimination, he is practically always healthy. On the other hand, there may be disturbed physiology without adequate elimination, causing a few complaints, but the parents and attending physician state that the child will outgrow this condition. If an intelligent adult presents himself with a chronic disturbance of the gastro-intestinal tract, he will usually state that the condition has

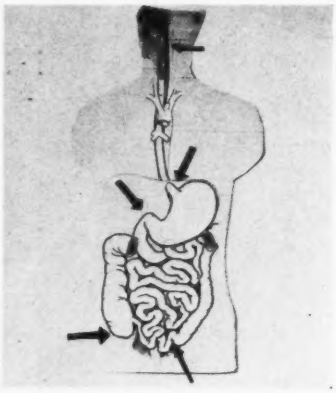

Fig. 3. Sites of the most common lesions of the alimentary tract and also the sites of greatest stress during the life-span.

been present to a greater or less extent since childhood, and it will be further observed that this disturbance will continue. Almost all physicians, and particularly roentgenologists, have observed an irritable duodenum in a young adult as portrayed by the roentgenogram, with subsequent demonstration, in a few years, of a definite ulcer. Few if any, however, have observed the changes in the gastro-intestinal tract in such a patient which may take place through the progress of years from infancy into adult life. In other words, there are no adequate records portraying the subsequent events, after many years, in a child with a disturbance of the physiology of the gastro-intestinal tract. Records are not available for definitely proving the beginnings of the disease of the adult gastro-intestinal tract.

COMMENT

The roentgen examination, after many years of trial, has proved to be one of the most efficient means for demonstrating not only the diseases of the gastro-intestinal tract but also the anatomy and the physiological variations of this anatomy. Such portrayals can be made of the living with ease and offer an opportunity for the study of that age group between infancy and early childhood and adult life. These studies can be made both by the usual method of selecting a certain number of persons in the various age periods, or, still better, by the progressive examination of the same person from infancy through adolescence and into adult age. The roentgenologists and pediatricians have such an opportunity to study the chronic functional diseases of childhood and the beginnings of the diseases of adult life which may result fatally at fifty years of age. If the gap in our knowledge between that of the younger child and the adult could be filled in, there would certainly be a more intelligent understanding of the chronic diseases of adult life. Likewise by such knowledge many of the functional diseases of early childhood could be corrected and later catastrophies prevented.

SUMMARY

(1) Although at times obscure, there is adequate information in the literature concerning the gastro-intestinal tract of the infant, and certainly the information is plentiful concerning the adult. There is, however, lack of correlation in the studies of the infant and the adult.

(2) Some of the differences in the anatomy, physiology, and pathology of the infant, young child, and the adult have been briefly pointed out here.

(3) Further studies, especially by roentgen examination of the intermediate group between the young child and the adult,

will be valuable particularly in furthering our knowledge of the progression of the gastro-intestinal tract from early childhood into adult life. Such knowledge would offer some hope for the prevention of many of the diseases of adult life and the production of healthier people.

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DISCUSSION: CHOLANGIOGRAPHY; GASTRO-COLIC FISTULA; THE GASTRO-INTESTINAL TRACT OF CHILDREN AND ITS RELATION TO THE ADULT

James T. Case, M.D. (Chicago, Ill.): Dr. Altman has given us a good idea of the frequency with which gastrocolic fistulae are encountered. I was glad to note the emphasis he placed on utilizing small amounts of opaque material in beginning his studies. That is coming to be a general practice in most examinations of the gastro-intestinal tract; we are using less and less contrast material. I remember when it was customary to give 12 to 14 ounces, or even more, especially in studying the duodenum. A. C. Jordan used to recommend really large quantities of opaque material to bring out obstructions and kinkings of the duodenum which were real or alleged. It is curious that we no longer seem to find as many of these duodenal obstructions.

The first essayist has demonstrated very clearly how important it is to have the preliminary films with a small amount of dye in the common ducts, later confirming the studies by more voluminous injections. We are glad to have his help in differentiating between air bubbles and gallstones.

Dr. McDonald's study of internal fistulae is also interesting. None of us see very many of these cases. Better technic in gastrojejunostomy, keeping the mesocolon as far away from the colon as possible, is resulting in fewer postoperative ulcers of the gastrojejunal type, and therefore fewer gastrojejunocolic fistulae. So-called "spot" films of some of these lesions, to bring out in greater detail their exact pattern, would have been instructive. Many of these cases, however, were examined years ago, before we got in the habit of making these small "aimed" films.

The position of the gastrocolic and gastrojejunocolic fistulae presents a difficulty, as they lie pretty well up under the ribs, where it is difficult to make compression, and very often we are not able to get the hands or compressor over the lesion.

Our President-Elect chose a timely topic, one which I personally am scarcely fitted to discuss, for I see few children in my practice. It is a fact that the child's bowels move almost every time he eats. I have observed in studying the motor phenomena

of the adult colon that the easiest way to stimulate the production of mass movements is to make manipulating maneuvers over the ileocecal region such as one would make in studying the appendix or the mobility of the terminal ileum. These mass movements are the forerunners of bowel evacuations.

In children I have sometimes seen the evidence of colonic stasis confirmed—evidence as shown by the ingested residues—by giving a barium enema at another time when the colon was filled with non-opaque residues, in which case the latter produced large or more or less characteristic filling defects within the pattern of the colon, as shown by the opaque enema.

I am interested to hear that the appendix is not often seen in young infants. It has been my experience that we usually find the appendix in children.

E. N. Collins, M.D. (Cleveland, Ohio): I am particularly interested in Dr. Altman's report that in 8 cases in which cholangiograms were made only postoperatively, stones were found. This fact, of course, emphasizes the value of immediate cholangiograms made at the time of operation. If, however, the latter are made routinely in every instance of biliary surgery, even in the absence of usual indications for common duct exploration, is not the risk of operation unnecessarily increased? No one doubts the value of making postoperative cholangiograms routinely before removing a T-tube from the common duct.

Dr. Altman has certainly demonstrated the value of using various amounts of dye and taking several films, as has proved so important in the roentgen examination of other viscera. Before closing I hope that he will say more about the possible increase in risk of operation where immediate cholangiograms are made routinely, and whether or not unfavorable reactions to the dye have been experienced.

The observations of Dr. Ritvo and Dr. McDonald on gastrocolic fistula coincide with ours at the Cleveland Clinic. All our patients were males and in Balfour and Eusterman's series of 74 cases only one patient was a female. Why the female should be immune is difficult to explain, unless ulcers in the male are more severe.

The mortality rate of 85 per cent for the non-neoplastic cases, regardless of the type of treatment, means, of course, that every available diagnostic procedure should be used. It should be recalled that there are instances in which the roentgen examination results in negative findings, but in which a fistula can be demonstrated by giving a colored substance by mouth and recovering it in the stool immediately thereafter or by giving it by rectum and immediately doing a gastric aspiration.

The date at which these cases of gastrocolic fistulae were examined was not stated. I am wondering if today, with our increased knowledge of blood chemistry, vitamin deficiencies, etc., we could not save more of these patients.

The paper by President-Elect Dr. Wasson, in his usual comprehensive manner, revealed that more knowledge of the gastro-intestinal tract of children should give some hope in the prevention of many of the disturbances of adult life. We now believe that most of the functional disturbances originate in infancy and childhood, often due to the lack of proper home training and ignorance on the part of the parents.

In Dr. Wasson's closing remarks I hope he will tell us whether or not he has been able to demonstrate Meckel's diverticulum in many of his cases, and if he will say something about the incidence of diverticula of the duodenum and colon in infants and children as compared with adults. In our experience the incidence of diverticula of the colon in a review of several thousand roentgen examinations of the colon in adults has been 7 per cent.

Ross Golden, M.D. (New York City): We have been doing cholangiography both on the operating table and postoperatively. We do the postoperative cases on the fluoroscopic table, using hippuran. It is very nice to watch the opaque material flow into the duct. In many cases, if everything is normal, it will flow immediately into the duodenum and the injection can be stopped.

Spasm of the sphincter is quite common. Under the fluoroscope one can see the muscle at the sphincter and just above it contract and relax, and with the spot film device one can make either small or larger films when the filling is optimum. One can rotate the patient from side to side and uncover overlapping anomalous ducts.

I would not like to have to do cholangiography in any other place except on the fluoroscopic table with a spot film device. After filling the ducts one can switch over and take stereoscopic films if he wishes.

Peculiarly enough, most of the gas bubbles which we have seen turned out to be stones, much to the disgust of the surgeon, who hoped that the duct was clear. I should like to ask whether Dr. Altman has seen a clear duct at operation, with stones appearing later—probably coming down from the liver.

I should like to mention one incident which happened within the last month. A cholangiogram apparently showed a clear duct. The patient continued to have symptoms, however. The surgeon operated and found the stone in the common duct. We could not understand that until we got the stone and found that it contained considerable calcium and was just exactly as dense as the opaque material that we had used. If we had taken films without any injection, it probably could have been seen.

I am not qualified to discuss Dr. Wasson's problem. I can only venture the hope that he will be able to continue his study and give us further comparisons of children and adults.

Samuel Brown, M.D. (Cincinnati, Ohio): I just want to ask a question. Does obstruction always indicate a stone in the common duct? I know of

one case, following an operation for gallstones, in which no bile drained through the opening. Injection of lipiodol revealed complete obstruction. It was presumed that a stone blocked the passage. In the absence of any other symptoms, however, it was decided to leave things alone. The patient made a complete recovery and so far, after two and a half years, has had no recurrence of symptoms.

William S. Altman, M.D. (*closing*): Dr. Case asked about the differentiation between air bubbles and gallstones. We find this to be our most difficult problem. In fact, it is one of the main reasons that caused me to institute the fractional method.

This method makes some diagnoses less difficult. In reviewing the cholangiograms I noted that those done in the operating room had a much lower incidence of questionable shadows than those done postoperatively. Lately we have tried to change the position of the patient, tilting the foot of the table down, to see whether or not air bubbles ascend. We have had distinct success in one instance in which we knew there was a stone. It had been shown in the first postoperative cholangiogram, was suggested in the second, but was not seen in the third.

This patient was x-rayed on a tilt table in the fluoroscopic room. Spot films were taken in the upright position. The stone then dropped down, apparently from a dilated cystic duct, into the ampulla of the common duct and became visible.

Dr. Collins asked about the 8 out of 35 cases which showed stones. The surgeon in chief does cholangiography on all his patients, private or ward. Of these 8 cases, it so happened that in none was operation done by him. The surgeons who did operate in these 8 cases then realized the value of immediate cholangiography and subsequently employed the procedure.

As far as the risk is concerned with the fractional method: in 109 cases there was only one death and that occurred in an acute surgical emergency. The patient died of acute renal failure after three days and we feel that cholangiography did not contribute to his death.

We have had some reactions in postoperative cases when using hippuran as a contrast agent. Some patients had a rise in temperature and some pain, but since using diodrast there have been no reactions.

There has been one other instance that I can recall, in the older group, in which the surgeon thought that cholangiography might have been partly to blame for the patient's death. There was no postmortem examination, however. We are firmly convinced that there is absolutely no added risk.

With the catheter method there is no need of perforating the common duct, so there is no chance for a leak through any needle hole.

Dr. Golden mentions postoperative cholangiograms done on the fluoroscopic table. We have done some and it is a common procedure. With us it is a question of economy of time and space. We have only one fluoroscopic room in use and it is not always available.

The question was asked: "How often has a duct appeared clear and later shown a stone at operation?" Of those cases in which the duct was shown to be clear by x-ray and no T-tube was put in, we do not know. To our knowledge none of these patients had to return.

In the other group, in only one case, as far as we could tell by postoperative cholangiography, did we fail to see a shadow in the common duct. A review of the first films showed a shadow that was suspicious.

The surgeon in many cases will explore the common duct beforehand and take only a check-up cholangiogram. This cuts down the incidence of x-ray visualization of stones.

Dr. Brown asked whether obstruction always means stone. Most of the positive cases, of course, have shown obstruction at the ampulla, apparently due to spasm. We have found that amyl nitrite has helped materially. In many cases we have eliminated spasm either by keeping the pressure low during the injection or by the use of amyl nitrite. In this way we could often demonstrate dye in the duodenum and even in the ampulla.

W. Walter Wasson, M.D. (*closing*): In reply to Dr. Collins' question in regard to diverticula, I wish to point out that to demonstrate these in the small intestines in an infant is difficult because the segmentation shadows of the small intestine are so similar to those produced by diverticula. That would also be true of the duodenum. The diverticula that we see in the adult duodenum are similar in appearance to the segmentation seen in the small intestine of the infant.

Not nearly enough examinations have been made of the child and young adult to give us any concept as to the percentage of diverticula. The number examined by any one radiologist is so small, as compared to examinations of adults, that comparison is difficult. Certainly we do not see diverticulitis in the infant or young child. We may find diverticula when more children are examined.

I have been interested in making this presentation chiefly because I have felt that so few of us are familiar with the intestinal tract of the infant and young child. It is my conception that we can no more build up our knowledge of the gastro-intestinal tract without a knowledge of the infant and young child than we can of the chest.

There are two ways to approach this problem. One is to study groups in the different age periods and by compiling them build up something of the picture of the progression of the intestinal tract from infancy to adult life. The other way is to study the same child over a period of years. The latter would require that our younger men take up the study of the gastro-intestinal tract from the standpoint of progression from infancy into adult life.

A Roentgenologic Consideration of the Normal Mucosa of the Duodenum[1]

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THE RECENT impetus given to the study of the mucosa of the gastro-intestinal tract has opened up a wide field for the roentgen investigation of minimal changes occurring in early pathologic conditions. It is well known that the roentgen detection of minute changes in the mucosa has by no means been exhausted; on the contrary, further investigative work is constantly bringing to light newer aspects of mucosal changes which are of considerable diagnostic importance. The roentgen method of examination offers the best and most accurate means of appraising the interior of the duodenum. A painstaking study of the mucosa of the duodenum should aid materially in widening the scope of our knowledge and in crystallizing and enlarging the roentgen picture of early affections involving the mucosa. This presentation is primarily concerned with the interior of the ampullary portion of the duodenum.

In a perusal of the literature little mention is found of radiologic studies of the mucosa of the duodenum, especially of the descending segment. It is surprising that so little attention has been directed to this most important portion of the intestinal tract. Since the duodenum is the most protean and active segment of the intestine, a careful study of the mucosa and its interior configuration is of great importance in establishing radiologic criteria for the diagnosis of early pathologic conditions. Heretofore, early changes in the second portion of the duodenum were often overlooked and frequently misinterpreted.

The radiologic picture of the duodenum is ordinarily a relief of the interior. The normal duodenum remains empty only after the stomach has completely emptied. Normally the transit of a barium meal through the duodenum is extremely rapid, but owing to the intermittency of the spurts of barium from the stomach, the duodenum is rarely empty during initial roentgen examination. The barium ordinarily remains in the second portion only for a few seconds, which is in most instances long enough to obtain a view of its contour. The interior of the duodenum is demonstrated better than other parts of the small intestine because the view is unobstructed and a clear picture of the entire second portion can usually be obtained without difficulty. The mucosal folds, major papilla, and other details are best observed in serial roentgenograms, preferably without compression. Compression is at times necessary, however, to delineate clearly minute changes. Fluoroscopy does not as a rule portray the finer details with clarity.

The descending portion of the duodenum is especially interesting because of its relation to the head of the pancreas and the biliary and pancreatic ducts. The common bile duct passes behind the superior duodenum, descends to the inner side of the second portion on the mesial aspect, joining with the pancreatic duct. The bile duct passes through the wall of the duodenum and traverses the duodenal structure obliquely for about 1.0 to 1.5 cm. According to Cunningham, the bile and pancreatic ducts, as a rule, do not unite until they have almost reached the opening of the papilla. The two ducts unite within the wall of the duodenum, forming a short dilated duct, known as the ampulla of Vater. Occasionally the common bile duct

[1] From the Department of Medicine, Dr. Maurice C. Pincoffs, Head of the Department, Gastro-enterological Section, University of Maryland. Read before the Radiological Society of North America, at the Twenty-sixth Annual Meeting, Cleveland, Ohio, Dec. 2–6, 1940.

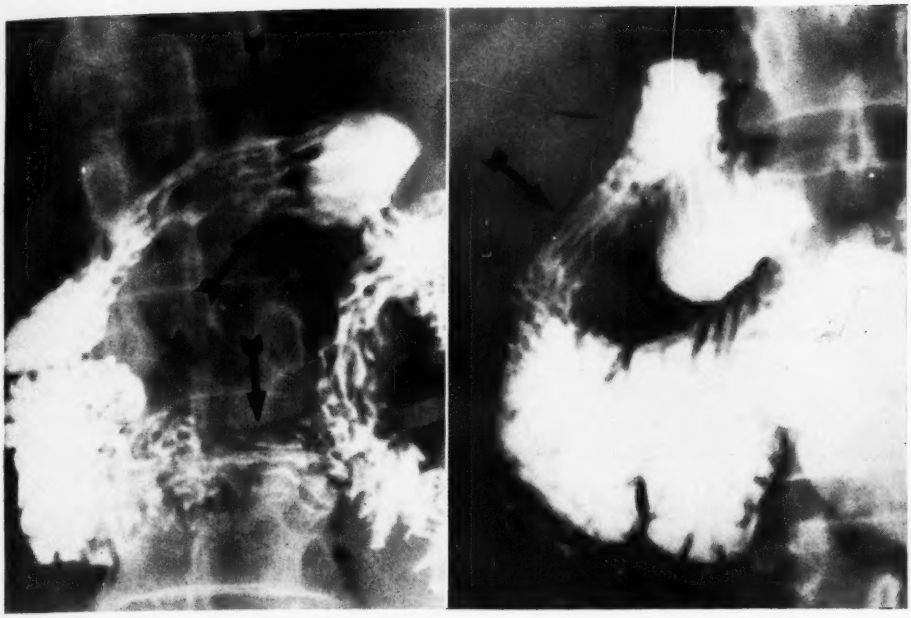

Fig. 1. Left: Normal characteristic longitudinal mucosal folds in the duodenal bulb. Note the folds carried over into the descending portion. Also note the longitudinal folds in the transverse segment of the duodenum. Right: Longitudinal folds in the duodenal bulb in the superior aspect. These folds are overshadowed at the duodenal angle, are again observed in the upper portion of the descending duodenum, while the lower portion of the descending duodenum is overfilled producing slight dilatation.

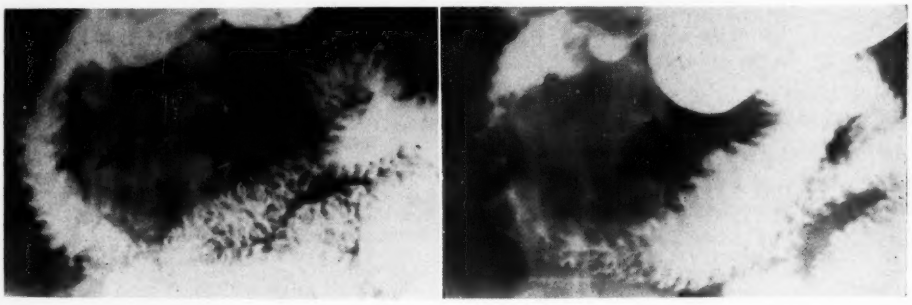

Fig. 2. Left: Characteristic normal deep transverse folds in the descending duodenum at arrow A. A relief view of the mucosal folds is seen in the ascending duodenum (B). Right: Emptying of the descending duodenum and the filling of the ascending duodenum. Note the normal deep transverse folds indicated by arrow.

and the pancreatic duct open independently into the duodenum. The distal end of the ampulla narrows and opens on the duodenal mucosa through the duodenal papilla. The papilla may be depressed, but usually it protrudes slightly into the lumen.

The interior of the first portion of the duodenum normally presents from four to six low, shallow, longitudinal folds, which at times may be seen to pass into the descending duodenum. These folds, while not constantly seen, are especially observed during the emptying of the bulb or upon slight compression. They are easily obliterated. Longitudinal folds are the only folds that can be radiologically demonstrated in the bulb. There are no visible transverse folds here.

The mucosa in the interior of the second or descending portion of the duodenum

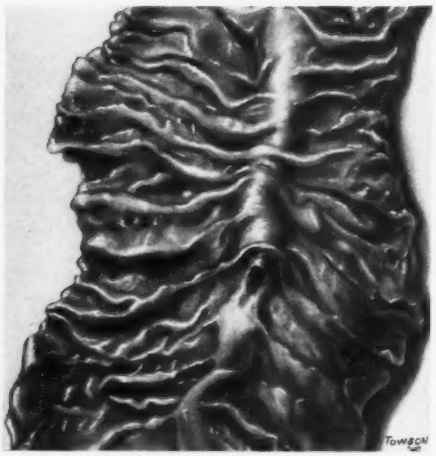

Fig. 3. Drawing (enlarged) of a normal segment of the ampullary portion of the duodenum from a cadaver specimen, showing the normal plica longitudinalis duodeni and the transverse folds (Kerkring's folds), some passing over, while many seem to end at the elevation produced by the plica longitudinalis. Note the transverse fold forming a hood-like elevation atop the papilla. The papilla opening is directed downward, the longitudinal fold extending below the papilla for a varying distance.

takes the form of large transverse circular folds known as Kerkring's folds, *valvulae conniventes*, or *plicae circulares*. These folds project into the lumen, increasing considerably the area of the mucosal surface. The duplicating folds consist not only of the mucosal layer but, according to Piersol, also contain a central supporting projection of the submucosa, and for this reason are constant and do not disappear under compression. The folds usually begin at the angle formed by the superior and descending portions, and are at first low, scattered, and irregular, gradually becoming larger, deeper, and more numerous. Beginning at the point where the papilla enters the duodenum the folds are very large and closely set. They are largest and deepest in the mid-duodenum and become shallower caudalward. The folds extend transversely, encircling the lumen either completely or partially, and run approximately at right angles to the long axis. Some are directed spirally.

The duodenal mucosa resembles that of the rest of the small intestine, but the mucosa in the descending portion possesses structures of especial interest. This portion of the duodenum contains two openings with projections into its lumen. In the ampullary segment, at the junction of the posterior and left wall, there normally appears a slight elevation produced by the common bile duct as it passes through the wall of the duodenum. Over this area may be seen a low, broad longitudinal fold, the *plica longitudinalis duodeni*, which becomes more prominent at its lower end. The major papilla is situated just below this fold, which ends in a prominent hood-like circular fold atop the papilla. The plica longitudinalis is interrupted by the major papilla, but descends for some length below the latter structure, forming a frenum-like fold, which fixes the papilla and directs its apex somewhat downward. The bile papilla or major papilla projects into the lumen as a prominent nipple-like protuberance. At the summit of the papilla the bile and pancreatic (Wirsung) ducts empty into the duodenum through a small orifice about the size of a pencil point. About 2 cm. cephalad and in front of the major papilla is a second or smaller projection, the *papilla minor*. The latter, although constantly present, is sometimes so small that it may escape attention. When the surrounding mucosa is well developed it may present characteristics, such as a hood-like circular fold and a little frenum, like those surrounding the major papilla.

The roentgen literature and textbooks make little or no mention of the radiologic appearance of the normal longitudinal folds, *i.e.*, those observed during peristalsis, and the plica longitudinalis duodeni. The anatomical and histological textbooks describe the transverse folds and the plica longitudinalis duodeni, but they, also, fail to mention the longitudinal folds normally seen during peristalsis.

The plica longitudinalis may be demonstrated radiologically in some instances in a relief view of the interior of the duodenum. This fold is portrayed as a single longitudinal negative shadow. At its be-

ginning it appears to be shallow, but it becomes more prominent at the ampulla, as it approaches the papilla. The normal plica longitudinalis varies from 4 to 6 cm. in length and from 2 to 4 mm. in width. Some of the transverse folds may be seen to cross it, while others seem to end abruptly here. In only a very small percentage of cases can the plica longitudinalis be demonstrated. In some instances a part of the fold may be seen, while in others the entire length is observed. It may be seen in only one or two films in a large series, and is better demonstrated in some phases of filling or emptying than others. It is perhaps best seen when the duodenum is partially filled.

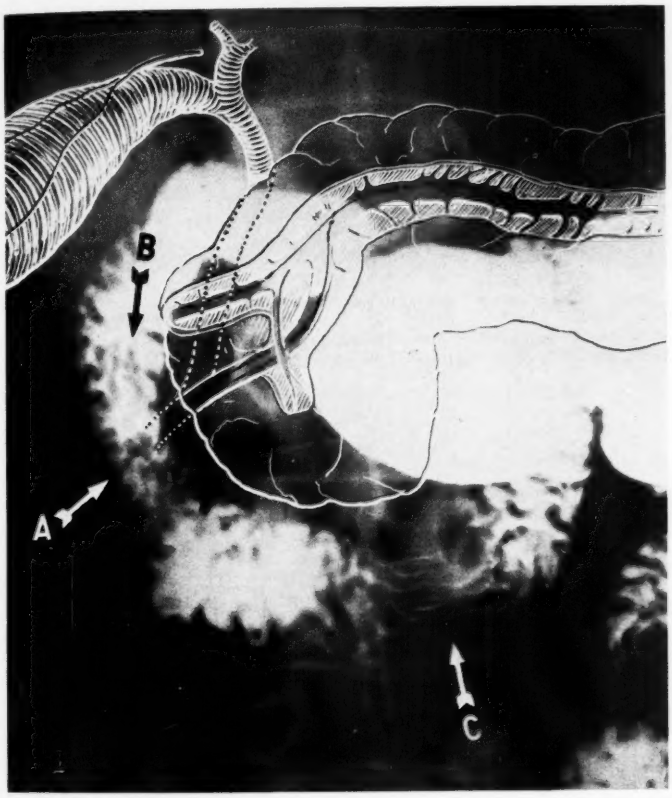

Fig. 4. An enlarged roentgenogram of the duodenum, illustrating the appearance of the normal plica longitudinalis duodeni at arrow B. At its lower end is shown the papilla at arrow A. The head of the pancreas with its ducts and the common bile duct are shown in relation to the major papilla. Note also a small segment of longitudinal folds due to peristalsis, at the junction of the transverse and ascending duodenum, at arrow C.

The radiologic visualization of the normal major papilla has likewise received scant attention. There is no question that the normal papilla can be demonstrated at times in the mucosal relief view of the duodenum. It presents itself as a small negative shadow, varying from 3 to 5 mm. in diameter, of smooth round contour, in about the center of the ampullary portion of the duodenum, in the mesial aspect. On close observation the circular hood-like fold surrounding the papilla may occasionally be seen in the lower end of the plica longitudinalis. The papilla protrudes into the lumen of the duodenum for a distance of 1 to 3 mm., though in some cases it may be depressed. The incidence

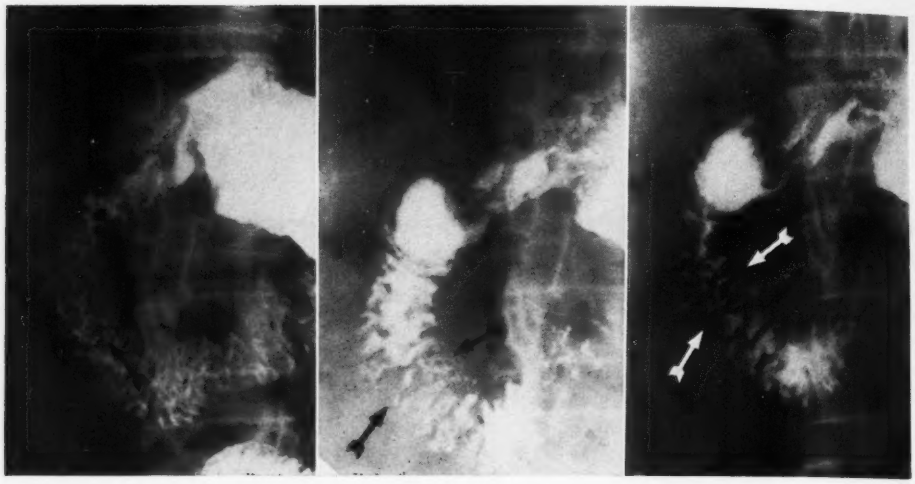

Fig. 5. Left: Relief view of the normal duodenal folds. Note the small rounded negative area at arrow representing a normal sized papilla. Center: The duodenal folds are partially filled. Note the splitting and somewhat widening of the folds in the papillary region at arrows. Right: The papilla is shown at arrows. Note the tendency to splitting of the folds in the papillary area.

of visualization of the normal major papilla by means of roentgen rays has not been recorded. As far as can be ascertained there has been no record of the roentgen visualization of the normal papilla minor. Enlargement of the papilla has been radiologically recognized, and a few such cases have been reported.

Of importance, too, is the radiological demonstration of longitudinal folds other than the single broad plica longitudinalis. In the onward movement of duodenal peristalsis caudalward, longitudinal folds are frequently observed in small segments of the duodenum. These folds are multiple, numbering between five and ten, and may be seen at times extending from the superior portion of the duodenum into the descending segment. They may be seen in all parts of the duodenum. They are usually observed in short segments with intervening transverse folds. The folds are short, shallow, thin, evenly distributed, and are easily obliterated. Since the transverse folds predominate in the duodenum (excluding the bulb), the longitudinal folds are not seen at all times. In the relief picture they appear only during the emptying phase, and even at this time they may not be constantly observed in all roentgenograms.

SUMMARY

The normal mucosal folds of the duodenum have been given scant consideration in the roentgen literature. They are described here and their roentgen appearances are reproduced. The normal relief view of the interior of the duodenum is shown, with a discussion of the roentgen demonstration of the special structures in the interior of the ampullary portion. The normal radiologic appearance of the major papilla is demonstrated, and the normal anatomic findings in the interior of the duodenum with special reference to the terminal common bile duct and duodenal papilla are presented. On the basis of these observations, early manifestations of disease affecting this segment of the intestinal tract is made possible.

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The Clinical Significance of the Roentgenologic Findings of the Small Intestine[1]

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THE SMALL intestine is one of the most important parts of the gastro-intestinal tract. It has been termed, classically, the engine room. Many evident and obscure symptom complexes have their origin here. Rapid progress is being made in evaluating its disturbances. The Miller-Abbott tube for intubation of the small intestine to study its muscular activity is of diagnostic value. The recent reports of Abbott and Johnston (1) and Ingelfinger and Abbott (2), and other papers by these collaborators, have thrown much light on the surgical conditions as well as the motor activity of the bowel. Recent contributions by Gershon-Cohen and Shay (3), concerning barium enteroclysis with small amounts of barium introduced through a duodenal tube, mark another step forward in the solution of some of the problems of the small intestine. These authors were able to demonstrate roentgenologically movements of the small bowel that had not been previously shown. The objections to this method are, of course, that all patients cannot swallow a duodenal tube and that it may be much easier to get the information by ordinary means of approach. In view of the complexities of metabolism and digestion in the small intestine, definite patterns resulting from any disturbance will probably never be demonstrable, and it is only by a correlation of the clinical manifestations with repeated x-ray observations that physicians will be able to come to some definite conclusion as to the pathognomonic roentgen findings.

I do not propose to discuss the clinical significance of the roentgen findings in neoplasms of the small intestine. What I am particularly interested in is emphasizing the importance of the roentgenologist to our knowledge of the small intestine.

Diarrhea and frequency of bowel movement are often diagnosed under the misleading term "colitis." This covers a multitude of sins. One is impressed, however, with the clinical picture of a diarrhea that is not of colonic origin. Unless there is evidence of organic obstruction or ulceration, the diarrhea is usually more or less painless and is associated with the expulsion of large amounts of water and very little, if any, tenesmus and griping in the rectum. The colon in such cases usually shows no changes except those of hypermotility. Rapid peristalsis of the small bowel leaves little time for absorption of an adequate amount of minerals, vitamins, and nutritional factors. This accounts for the rapid loss of weight and the usual signs of inanition that follow chronic diarrheas. Disturbances of the mineral balance produce more or less of a vicious circle. Sooner or later edema supervenes, with hypoproteinemia and hypochloremia; the intestine becomes swollen and edematous; the movements become more sluggish; large amounts of fluid collect, and if the process goes on long enough, severe alkalosis becomes evident. Blood examination in the presence of such a condition reveals a hypoproteinemia, a reversal of the albumin-globulin ratio, marked depletion of the chlorides, elevation of the CO_2 into the alkalosis phase, and possibly increased blood urea. If the clinical course is not interrupted, death may supervene.

Mackie and Mills (4), in a study of 28 cases, failed to find any significant correlation between the presence of abnormalities of the small intestine demonstrable by roentgenologic examination and the level of the plasma proteins or chloride, the presence or absence of gastric hypoacidity or

[1] Read before the Radiological Society of North America, at the Twenty-sixth Annual Meeting, Cleveland, Ohio, Dec. 2-6, 1940.

anacidity, or demonstrable gastro-intestinal food allergy. I cannot subscribe to their statement in its entirety. Anyone who has had sufficient roentgenologic experience and has seen patients with achlorhydria may look at a series of films taken for motility of the small intestine and postulate that a particular patient has no free acid even before gastric analysis, which usually confirms the original impression. This is illustrated by the following case:

Mr. W. B. F. consulted me on July 5, 1940, complaining of what he called a "dysentery," of two and one-half years' duration. For the past two and one-half years he had had frequent watery stools, and the condition had become progressively worse. There had never been a complete remission, but occasionally there was a formed stool. No pus or blood had been noticed, and only rarely did cramp-like pains occur. The patient had been treated for amebiasis, "colitis," and many other conditions. His physical examination gave essentially negative results. The proctoscopic examination revealed no abnormality. The laboratory study of the urine was non-contributory, and the stool showed no evidence of *Entamoeba histolytica* or cysts on either smear or subsequent culture. Agglutinations for the various dysentery organisms gave negative results. Examination of the blood showed a mild hypoproteinemia and a low chloride value. Wassermann and Kahn tests were negative. Roentgen examination revealed a normal gallbladder, a normal stomach and duodenum, and a gastric emptying time of one hour. Motility of the small intestine was rapid, and barium reached the descending colon at the end of an hour and was in the rectum at the end of two hours. The opaque enema revealed nothing unusual in the colon. I remarked in reviewing the films that the patient would probably have an achlorhydria. Subsequent Ewald and histamine tests revealed the absence of free hydrochloric acid.

Achlorhydria, except with pernicious anemia, is not uncommon. Parenthetically, pernicious anemia frequently develops in such patients during their later years. Rapid peristalsis of the small bowel, associated with an anacidity, ultimately results in loss of weight and appetite and vitamin imbalance. Early, these patients do not, as a rule, have clinically significant changes in the plasma protein or chloride level. However, it is to be suspected that if the process goes on long enough, the carbohydrate reserve of the liver will, sooner or later, be depleted owing to malabsorption. Necessarily liver function will be distinctly impaired, since the function of the liver is, for the most part, dependent on the glycogen content of the liver cell. Therefore, we may see the type of patient who, as the result of a long-standing small bowel diarrhea, has definite liver disease. Further, since the bactericidal activity of the gastric juice is lost, ascending hepatic infections from the fecal flora which may be present in the jejunum are more likely when the reserve of the liver is markedly depleted. Also, there may be an associated deficiency of the vitamin B complex.

Vitamin B_1 disturbances are not infrequent. In this condition, one sees segmentation of the small intestine with corresponding dilatation of the individual coils or groups of coils. Also the roentgen findings in the ileum are much more constant. Here the mucosal pattern may be definitely distorted, as evidenced by atrophy and irregularities in the absence of ulceration. Distinct ballooning out of portions of the terminal ileum may occur. One should learn, of course, to differentiate clinically between the so-called deficiency states and deficient intestinal absorption. For example, idiopathic steatorrhea is primarily a disease of deficient intestinal absorption. There may be a definite disturbance in the tonus of the small bowel in the presence of vitamin B deficiency. Cowgill (5), as cited by Pendergrass, has shown, in studies of the digestive tract of dogs suffering from vitamin B complex deficiency, that during periods of complete anorexia the stomach emptying was delayed up to six hours, and spasticity and delayed motility of the small bowel were observed. After the administration of thiamin chloride (vitamin B_1), the appetites of the dogs returned. The small intestinal gradient was re-established to some extent, but the pattern simulated that found in non-tropical sprue. There were boluses of various sizes, some small and others large, and the barium was distributed throughout a larger portion of the small intestine. When whole yeast was

given, however, complete recovery took place if the deficiency state had not existed too long.

Vitamin A disturbances of the small intestine may be confused with the clinical picture of idiopathic steatorrhea. Chesney and McCoord (6) were able to differentiate the clinical picture of idiopathic steatorrhea from that of chronic diarrheas on the basis of the vitamin A absorption curve. They found, after the ingestion of oil of high vitamin A content, such as haliver oil, a marked increase in the intensity of the Price-Carr reaction for vitamin A as observed in the blood serum of normal persons. The degree of this increase may indicate the ability to absorb vitamin A. For six patients with idiopathic steatorrhea, they found the rise in vitamin A in the serum much less than that of normal children, and as the patients improved there was a corresponding rise in the serum level. It was concluded that the low values were associated with faulty absorption, whereas in chronic diarrheas the vitamin A absorption curve was found to be normal. By this means, of course, we may be able to differentiate these two clinical conditions in children.

Idiopathic steatorrhea is an interesting clinical syndrome. It is closely related to tropical sprue and non-tropical sprue in adults and is strictly a failure of absorption, since there is no difficulty in splitting either the fats to fatty acids and soaps or the carbohydrates to the simple sugars, because the corresponding ferments are present and active. In active steatorrhea the mucosal changes are striking. They take the form of coarsening or ironing out the valvulae. This is especially evident in the jejunum and may even occur in the distal portion of the duodenum. Kantor (7) has shown that the obliteration of the valvulae may be so complete that roentgenologically the bowel resembles a tube into which wax has been poured and allowed to harden. In order to call attention to this characteristic wax-model appearance of the jejunum in steatorrhea, he suggested the descriptive term "moulage sign." In his experience the "moulage sign" furnished the best visual evidence of the activity of the disease, appearing with exacerbations of the steatorrhea and disappearing with its remissions. He therefore suggested that this might serve as a useful aid not only in diagnosis but in prognosis.

In addition to the disappearance of the valvulae, there may be a dilatation of the small bowel lumen and spasm, with sausage formation or segmentation. This segmentation may even take on the appearance at times of a large diverticulum. The motility of the small intestine is usually delayed. The mucosal changes in the small intestine are probably associated with an edema and a superimposed infection. In addition, there may be a derangement of the motor function and variations in the muscular tone. In long-standing disease there are concomitant roentgen findings in the colon, gallbladder, and bony skeleton.

In non-tropical sprue one may find a normal fine-feathered appearance of the jejunum, possibly resulting from the infiltration of the wall of the gut, inflammation of the mucous membrane, or even atrophy of the wall. While the disease was formerly thought to be associated with chronic pancreatitis, the fat and foamy stools are the result of an atrophy of the absorptive surface of the intestinal tract.

In this decade, our attention has been called to the frequency of regional ileitis or regional enteritis, or, as it has been called, regional enterocolitis, described by Crohn and his associates. Increasing observations by other clinicians have added a great deal to our knowledge of this condition. The roentgen picture is more or less pathognomonic, and since its discovery observations on the small intestine have been stimulated. Occasionally, however, this clinical picture may be overlooked in the early stage, because of the superimposed coils of the small bowel in the right lower quadrant. This may be obviated by retrograde enema and by forcing barium into the distal part of the ileum, to reveal changes which may not be evident during a progress meal. The widespread distribution of

this disease in the small intestine is obvious and it is to be remembered that involvement may at times occur high up in the jejunum, although this is rare. Changes in the mucosal pattern and in the borders of the localized lesions have been reported by numerous observers. At the present time, with the origin of this disease still obscure, surgical measures offer the best therapeutic approach, the type of operation being dependent on the pathologic picture as to its extent and the corrective measures to be employed. The difficulty, of course, not only preoperatively but even at operation, lies in the differentiation of this disease from hyperplastic tuberculosis.

Polyposis is not uncommon in the small intestine; it is not as frequent, however, as in the large bowel. Frequently, polyps may produce an intussusception. Careful roentgen study of the small bowel, especially in routine gastro-intestinal examination, may reveal localized polyps. It is to be remembered that polyps anywhere in the gastro-intestinal tract are potentially malignant, and when localized polyps are found in the small bowel they should not be looked on as innocuous. If they are diffuse, of course, nothing can be done, but when they are single or limited to a definite area, if it can be well defined, surgical intervention may be indicated to prevent malignant transformation. The polyps may have a tendency to bleed and to obstruct, as mentioned before, but for the most part they are an accidental finding during routine examination.

Meckel's diverticulum is not at all uncommon and may escape observation for years, until some acute manifestation supervenes. One may actually demonstrate the presence of a Meckel's diverticulum, usually in the lowermost 150 cm. of the ileum, by direct roentgen observation, or its presence may be suggested by exclusion of all other intestinal lesions with a similar symptom complex. In children, copious hemorrhage from the bowel without any previous clinical symptoms is always suggestive of a gastric rest in or about Meckel's diverticulum.

Diverticula of the small intestine are more frequent in the jejunum than elsewhere, but they may occur anywhere in the small bowel and are usually congenital and frequently multiple. They become clinically significant only when they are large enough to retain food over many days and have, at times, been the explanation for obscure gastro-intestinal complaints. Their removal has been followed by complete cessation of symptoms.

Tuberculosis of the small bowel and its roentgen manifestations are so well known that they need not be discussed here.

Recently at the hospital I had the opportunity of observing a patient with recurrent hyperpyrexia with a very definite filling defect of the upper part of the jejunum. Associated with this were nausea, vomiting, and the passage of occult blood in the stools. This clinical picture had been present for years, and because no pathognomonic findings, from the point of view of blood or other serologic examination, were evident, a diagnosis of abdominal Hodgkin's disease was entertained. Operation was advised for the relief of an incomplete obstruction in the jejunum, and my clinical impression was confirmed, for a typical Hodgkin's involvement of the small intestine was found at the area localized in the previous x-ray examination. This was my first experience with Hodgkin's disease of the small intestine, with corresponding roentgen evidence.

Other disturbances of the lymphatic system may produce changes in the small intestine. Leukemic infiltrations are not uncommon and may occur without corresponding peripheral node enlargement. Thus, one may see, during a progress meal, distinctly lightened areas in the pattern, which are due to the projection of the elevated mucosa. Similarly, one may find a small dot-like lightened area in the lower part of the ileum, which may be due to hyperplasia of a solitary lymph node.

CONCLUSION

It is evident that the small intestine should receive increasing attention. Many

physicians are intrigued with the findings here and hope that clinical observations with corresponding roentgenologic data may help to develop certain definite patterns which may be of some pathognomonic significance. Unfortunately, at the present time, there seems to be no definite standardization of the technic of roentgen examination. I must confess that I am not at all impressed with the results of the present approach to this problem. We are now investigating the best approach, modifying the meals between small and large, adding various non-irritating drugs which delay motility, and hoping in the near future to have some evidence to present for the standardization of the technic of roentgen examination.

Finally, just as a quarter of a century ago the roentgenologist was called on to clarify the problem of peptic ulcer of both the stomach and duodenum, so again must the roentgenologist play an important part in solving many of the evident and obscure manifestations in the small bowel.

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DISCUSSION

R. John F. Renshaw, M.D. (Cleveland, Ohio): Not being a roentgenologist, I hardly feel qualified to discuss a paper of such a purely roentgenological nature as that of Dr. Feldman, but from a clinical standpoint it seems just as important to know the normal pattern of the ampullary portion of the duodenum as of any other portion of the gastro-intestinal tract, and from a demonstration of the finer detail of the normal mucosa to be able to go on and demonstrate some of the finer pathological changes.

I should like to ask four questions:

(1) What have been the variations from normal? What changes have been found in the same person examined on several different occasions under varying conditions?

(2) As Dr. Golden has shown,[1] emotion may have an important part in the change of the mucosal pattern of the small bowel. Has this been observed in the ampullary portion of the duodenum?

(3) What effect do different types of meals—barium-water, flavored mixtures, etc.—have?

(4) Finally, do disturbances of other portions of the gastro-intestinal tract, particularly the adjacent portions, the biliary system, have any effect upon the normal mucosal pattern?

Dr. Portis has emphasized the importance of small bowel studies. It seems to me that in the past our clinical diagnoses—with the exception of stenosis of the small intestine—largely pertained to the stomach, biliary system, and colon, with not much attention to the small bowel. Now the small bowel is coming into its own, is demanding more attention, and is entering the phase in which the study of the stomach was several years ago, when the roentgenologist was called upon to clarify the situation in duodenal ulcer.

I believe that a large number of the signs that are ascribed to vitamin deficiency are indirect signs, representing a non-specific reaction that might occur in many conditions. Dr. Portis has mentioned some of these. Recently I have been interested in gastro-intestinal allergy. Walzer and his co-workers have adequately demonstrated that edema and cellular infiltration is a significant finding in the wall of the intestine when an allergen is applied to it. Recently I have been able to make observations by the proctoscopic and gastroscopic methods, and I raise the question: Might not this same cellular infiltration and edema cause a disturbance in the small bowel, giving the pictures of segmentation, spasm, and the like?

It seems to me that, while Miller-Abbott or Osler-Abbott intubation was passed over rather quickly, it offers to clinicians the most significant method of learning more about the small bowel. I realize that it takes a great amount of time, patience, and labor, but I hope that those who have such facilities will continue with their studies.

Maurice Feldman, M.D. (Closing): Dr. Renshaw has asked about variations from normal.

[1] See Radiology **36:** 262–286, March 1940.

About three years ago, when we began the study of the papilla and ampullary portion of the duodenum, we were not able to obtain much information from the literature or textbooks. Our first problem, therefore, was to establish roentgen criteria for the normal, which I have attempted to present here.

In another communication I have considered the pathologic states which can be determined from observing the various changes that occur in the ampullary portion of the duodenum. Since the roentgen criteria are based upon anatomic grounds, abnormal changes must be persistent in order to establish a pathologic diagnosis.

Regarding the different meals, I do not think these play an essential part in the diagnosis of anatomic conditions as far as the papilla or the terminal common bile duct is concerned. They may, however, play some rôle in the mucosal markings.

As to other affections, there have been some changes in the ampullary segment in involvement of the head of the pancreas. I have reported the inverted-three defect that occurs on the inner border in very early changes in the head of the pancreas as the result of edema, and I have described similar changes secondary to duodenal ulceration.

I should like to re-emphasize the importance of recognizing the normal radiologic appearance of the interior of the duodenum, in the hope of stimulating some interest in this unexplored field of roentgenology so that early changes, especially in the terminal common bile duct, will be more readily recognized.

At the present time we look for pathology in the terminal common bile duct in the presence of jaundice but perhaps we can recognize such pathology before jaundice has occurred. This is one of the problems which is of special interest. A follow-up of cases where pathologic conditions of the terminal common bile duct are seen to determine whether we can diagnose lesions in this area before obstruction occurs is of considerable importance.

Roentgen Findings in Alkaptonuric Ochronosis[1]

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ALKAPTONURIA is a disease characterized by the excretion of alkapton in the urine. This substance, which has been identified as homogentisic acid, is apparently one of the products of a deranged metabolism which manifests itself mainly in the syndrome denominated ochronosis.

The subjoined report concerning two such cases is prompted by the exceptional interest which attaches to a metabolic anomaly of extreme rarity, of unknown causation, and of bizarre clinical manifestations.

HISTORICAL

Perhaps the earliest reports concerning patients voiding dark or black urine (or urine which turns reddish brown or brownish black upon exposure to the air) were made by Scribonius (1), Schenck (2), Marcet (3), Boedeker (4), and Brune (5). Garrod's whimsical description of a case reported by Lusitanus in 1649 (6) is worth quoting.

"The patient was a boy who passed black urine and who at the age of fourteen years was submitted to a drastic course of treatment which had for its aim the subduing of the fiery heat of the viscera which was supposed to bring about the condition in question by charring and blackening his bile. Among the measures prescribed were bleedings, purgative baths, a cold and watery diet and drugs galore. None of these had an obvious effect and eventually the patient who tired of the futile and superfluous therapy resolved to let things take their natural course. None of the predicted evils ensued, he married, begot a large family and lived a long and healthy life always passing urine black as ink."

INCIDENCE

The extreme rarity of alkaptonuria is shown by the fact that only about 100 cases have been reported to date in medical literature, and of this total, about 30 have been described in the United States. Poulsen (7) recognized the pigmentation in a man twenty-three years of age, and Kolaczek (8) in a man thirty years of age. The average patient is about fifty years of age. Persons of both sexes and of all types appear to be equally prone to the disorder, which incidentally persists throughout the life of the patient. Heredity seems to play a rôle in the anomaly. The 11 cases studied by Garrod (9) occurred in families in all of which the parents were first cousins. In one of our cases, this abnormality existed in two brothers of the patient, in three daughters, and in one grandchild.

ETIOLOGY

The metabolic mechanism responsible for this anomaly slips a cog, so to speak, and up to the present the cause has not been ascertained. Owing to a deficiency of a specific enzyme, as was emphasized by Gross (10), the amino acids—tyrosin and phenylalanine—remain unconverted into their end-products. The failure of a molecular breakdown beyond the stage of homogentisic acid, which appears to be an intermediate product of the normal metabolism of phenylalanine, results in the accumulation of that substance in the blood and its excretion in the urine. As a consequence amounts varying up to 4 or 5 gm. may be excreted in the urine in twenty-four hours. It has been shown that when homogentisic acid is fed to normal persons in large amounts a residuum may be excreted, but by the alkaptonuric the acid is wholly excreted. It is obvious, therefore, that these persons do not have the power of breaking down homogentisic acid when formed.

Wolkow and Baumann (11) postulated that homogentisic acid was derived from

[1] From the Departments of Radiology of the Hospital for Joint Diseases and Bellevue Hospital. Presented before the Twenty-sixth Annual Meeting of the Radiological Society of North America, at Cleveland, Ohio, December 2–6, 1940.

the proteins of the food and body tissues. This observation was shown to be correct when it was found that the alkapton acid could be increased by the ingestion of tyrosin, and was further confirmed by Falta (12), who in feeding experiments demonstrated that the excretion of homogentisic acid varies directly with the richness of the phenylalanine and tyrosin of the proteins taken. Investigation of this problem was continued by Mittelbach (13), who showed that abstinence from protein foods, although it reduced the quantity, did not completely eliminate homogentisic acid from the urine. The assumption, therefore, was that the tissue protein also contributed to the formation of this acid. One of our patients stated that the discoloration of the urine seemed to become intensified after he had eaten cheese. This was to be expected, since the casein of cheese is rich in aromatic fractions and will greatly increase the output of homogentisic acid in the urine, an observation experimentally proved by Langstein and Meyer (14).

CHARACTERISTICS OF THE URINE

Physical: When first passed the urine may show no abnormality. Gradually, however, on exposure to air, oxidation results and it turns black. Specimens of such urine may show successive layers of colors, varying from the deep black of the upper layer to deep brown and finally to an amber color. In children the urine is sometimes red rather than brown. In many of the originally reported cases, this condition was first discovered by the brownish or blackish staining of diapers.

Biochemical: Garrod's excellent review of the subject lists the following fairly simple tests for the determination of the presence of homogentisic acid in the urine: (*a*) exposure to the air, which causes the urine to turn black or brown; (*b*) addition of alkali, which produces a similar effect; (*c*) reduction of copper solutions; (*d*) non-reduction of alkaline bismuth solutions (Nylander's reagent); (*e*) non-reaction to fermentation tests; (*f*) non-rotation of polarized light; (*g*) reduction of silver lactate (the reagent of Folin and Wu) in the cold, an effect not produced by any other reducing component in the urine; (*h*) the addition of a dilute solution of ferric chloride, producing a transitory deep blue color; (*i*) reduction of silver nitrate in the cold (in the absence of ammonia); (*j*) addition of a 1 to 10 per cent ferric chloride solution to 5 c.c. of urine with a dropper, which reveals (besides the precipitation of ferric phosphate) a transitory greenish or bluish coloration (additional drops of the reagent, oxidation being complete, produce no color changes); (*k*) production of a yellowish precipitate by Millon's reagent (10 gm. of mercury in 20 gm. of nitric acid).

SYMPTOMS AND PHYSICAL FINDINGS

About one-half of the cases of alkaptonuria have been associated with ochronosis, a condition first described by Virchow (15) in 1866, as a postmortem finding, characterized by pigmentation of cartilages, tendons, ligaments, and the intima of large vessels. Garrod states that "in recent years, it has become evident that almost all if not all alkaptonurics who reach middle life develop ochronosis and that some develop it earlier in life. The majority of the patients who have been alkaptonuric, but a considerable number who are not alkaptonuric, had applied carbolic acid to ulcers of the legs during a long span of years. Patients of the latter class have not only black cartilages but also exhibit clinical features of ochronosis." Under ordinary circumstances, therefore, ochronosis must be considered as the clinical manifestation of alkaptonuria until some other etiologic background is determined.

Oppenheimer and Kline (16) have classified ochronosis etiologically as follows:

(1) Those cases due to the circulation in the blood, of certain aromatic compounds, with the excretion in the urine of homogentisic acid.

(2) Those due to the circulation in the blood, of certain aromatic compounds, with the excretion in the urine of melanin. In

this group there are but a few cases, of which the one reported by Oppenheimer and Kline is a good example.

(3) Those due to the circulation in the blood, of certain aromatic compounds, following the external use of phenol. These cases are relatively uncommon.

According to the above classification the two cases which we are reporting are of type one.

In most of the patients the abnormality appears to have begun in infancy or to have been observed over a period of years. The condition generally is asymptomatic and the metabolic fault is usually discovered by the color of the urine after it has been standing or by black stains on diapers or underclothing. Dysuria is occasionally noted.

On reaching middle age, patients with alkaptonuric ochronosis present a fairly typical picture. They appear to be poorly nourished and seem to be suffering from some debilitating illness. In both of the cases which we are reporting, the patients assumed a posture reminiscent of Paget's disease, with the head thrust forward so that the muscles of the neck appear to be unduly prominent. The chest is large and somewhat emphysematous. The torso is held rigid. The vertebral column is fixed; there is a dorsal kyphosis and the lumbar curve is accentuated or obliterated. The arms hang limply by the sides. The thighs are flexed slightly at the hip and locomotion is slow and distinctly impeded. The knees are held in flexed position and the entire lower extremity moves *in toto*. The feet are held in inversion and abduction.

Alkaptonurics with an associated ochronosis may exhibit swelling and deformity of one or more of the larger joints of the extremities or of the small joints of the hands, a condition termed by Osler (17) "ochronotic arthritis."

Clinical evidence of ochronosis is found in the yellowish or brownish mottled discoloration of the skin of the head, neck, torso, and to a lesser degree of the extremities. Pigmented surface areas appear brown, whereas similar pigmentations beneath the surface impart a bluish tint to the skin. Frequently early evidence of the disease is the grayish-blue discoloration of the ears first seen in the concha and the antihelix and then in the tragus and cartilage. On palpation, the ears feel rigid and somewhat nodular. Due to the deposit of homogentisic acid in the nasal cartilage, the nose acquires a bluish tint. The butterfly-shaped brown facial pigmentation described by Garrod has not been observed by us. The sclera are gray or slate-purple in color and characteristic triangular brownish patches are noted several millimeters to the temporal and nasal sides of the corneal limbus, with the bases toward the cornea and the apices toward the outer canthi of the eyes. These areas measure from 2 to 10 mm. across. Ocular function is usually unaffected.

The skin over the small joints of the hands often has a bluish discoloration due to staining of the tendons. The fingers are clubbed and the nails show a brownish pigmentation. In the axillae and genital regions the skin may be bluish green, due to pigment from the sweat and sebaceous glands. In addition to the pigmentation visible to the naked eye, similar depositions of homogentisic acid take place in the organs of the body. Many writers have stressed the common association of cardiovascular lesions with ochronosis, and it has been accepted that these changes, like the arthritic manifestations, are distinctly related to the metabolic anomaly.

ROENTGENOGRAPHIC FINDINGS

Gross and Allard (18) described the deforming arthritis of the larger joints in alkaptonuria, whereas Söderbergh (19) emphasized the roentgenographic features of the disease. In his four cases, there was an ankylosing process of the spine associated with a hypertrophic arthritis of the vertebrae, hips, and shoulder girdle. Because of the existence of alternating areas of osteoporosis and osteosclerosis of the bones he examined, Söder-

bergh suggested that the name "osteitis deformans alkaptonurica" be applied to this condition. It is probable, however, that the changes in the texture of the bones to which he refers are more or less dependent upon the inactivity occasioned by the ankylosing arthritis.

Scholz, reporting upon the roentgenograms of Oppenheimer and Kline's case of ochronosis, termed the condition spondylitis deformans and mentioned the calcification of the intervertebral discs without recognizing its true significance. In many of the cases reported, there was a well developed osteoarthritis characterized by the production of large osteophytes. Puhr (20) reported a case in which the bone changes were extreme and resembled those of osteomalacia, clinically, roentgenographically, and pathologically. The case recently reported by Manson-Bahr and Ransford (21) was a typical alkaptonuria with an ankylosing arthritis of the lower lumbar spine, with development of a psoas abscess from which hemolytic streptococci were recovered. The authors do not believe the abscess was in any way related to the alkaptonuria but regard it as merely a complication in a patient already debilitated by numerous tropical diseases.

The most characteristic roentgenographic findings of alkaptonuric ochronosis are noted in the spine, pelvis, shoulder, and knee joints.

Spine: In the dorsal region of the spine there is usually a fairly marked kyphosis, whereas in the lumbar region the normal lordosis may be either exaggerated or completely obliterated. The vertebral bodies are of approximately normal height or slightly diminished, in the manner common to most non-specific arthritides. All of the spinal segments appear to be fairly generally decalcified and they may show some vertical or linear striations or a peculiar granular halisteresis. The reactive osteitis noted by Söderbergh has not been observed in our cases. Fixation of the spine is effected by ankylosis of the vertebral bodies and their joints. The characteristic change is the universal calcification of the intervertebral discs. These appear as elliptical opaque wafers in all of the intervertebral joints and are most clearly seen in the lumbar area. So striking is this process that one of us (M. M. P.) identified the disease, in Case 1, solely from the roentgenograms. We believe this to be the first recorded instance in which the diagnosis was established in this manner. It is probable that the density of the intervertebral disc is due to secondary calcification following degeneration of the cartilage resulting from the deposition of homogentisic acid. In our cases, there was in addition universal calcification of the costal cartilages. Two of the daughters of one of our patients have intense premature calcification of the costal cartilages.

Shoulders: Fairly typical changes are noted in the shoulder joints. There is always a marked narrowing of the joint spaces so that very little if any of the joint is visible. The articular surfaces of the glenoid fossae appear eburnated and fairly large spurs project from their margins, particularly inferiorly. The humeral heads are somewhat mushroomed, and roughly circular areas of resorption are noted on their articular surfaces. Irregular flocculent calcific deposits are seen in the soft tissues, apparently distributed in the course of the supraspinatus tendons as well as within the subdeltoid bursae. In some respects, the roentgenograms of the shoulder joints are somewhat reminiscent of a neuroarthropathy.

Pelvis: The pelvic bones are slightly decalcified but there are no striations such as are seen in the vertebral bodies. The sacro-iliac articulations may be narrowed to a considerable degree, but recognizable calcifications are not seen in the joint cartilages. In one of our cases, there was calcification of the pubic cartilage with fusion of the pubic bones. The hip joints are of average width and the articular cartilages present no gross abnormality. Irregular flocculent calcifications are usually seen in the soft tissues between the heads of the femora and the acetabular shelves. Similar calcifications are noted

Fig. 1. Case 1. Narrowing of the vertebral articulations with extensive calcification of intervertebral cartilages; peculiar granular osteoporosis; ankylosis of spine with loss of normal curves.

in the tendinous attachments to the greater trochanters of the femora, as well as in the soft parts between the lesser trochanters and the ischial tuberosities, evidently within the ileo-pectineal bursae.

Knee: In the knee joints, similar depositions may be seen within the quadriceps tendons and to a lesser degree in the patella tendons. Although calcification of the semilunar cartilages has been reported, we have failed to observe it in our patients.

Ears: The roentgenograms of the ears of one of our patients with extensive pigmentation proved extremely interesting. Small calcific deposits were distributed within the helix and extremely large masses or collections were noted in the fossa triangularis and antitragus.

Small Joints: The small bones of the hands and feet may display nodular periarticular swellings without any of the depositions to which we have already referred. We have failed to note any specific

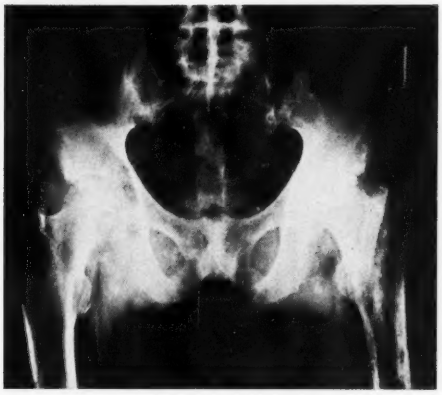


Fig. 2. Case 1. Calcification of interpubic cartilage with similar depositions in soft tissues of hip joints; partial synostosis of right sacro-iliac joint and fusion of lumbar spinous processes.

change in the width of the articulation or any calcification of the joint cartilage. Likewise, the articular surfaces of all the bones comprising these joints appear to be intact.

CASE REPORTS

CASE 1: F. D., white male, aged sixty, a cigar maker by occupation, was admitted to the service of Dr. I. O. Woodruff on March 25, 1940, complaining of pain in the left shoulder, hip, and knee.

His father had died of unknown causes when the patient was a child; his mother died of pneumonia at the age of 58. Two brothers and one sister were alive and well. There was no history of consanguineous marriages in the family, and no other member of the family suffered from alkaptonuria.

The past history showed the usual childhood diseases. There was a history of syphilis in 1920, but blood and spinal Wassermann tests were negative in 1922. The patient also had gonorrhea in 1904 and 1922. He was a moderately heavy drinker and smoker. He sustained an injury to the left eye eight years before admission and became totally blind in that eye.

The patient was apparently well until eighteen years before admission, when he experienced severe pain in the lower back. He went to Hot Springs, where he took the baths and received mercury inunctions, which relieved the pain, although some stiffness remained. He continued his occupation and was quite comfortable until about four years before admission. At that time, he began to suffer from pain and stiffness in the shoulders and right knee. For the past six months these symptoms had become so aggravated as to be almost completely disabling.

Fig. 3. Case 1. Calcareous deposits in patella tendon and popliteal space; unusually advanced Mönckeberg's arteriosclerosis.

The patient walked with a great deal of difficulty, had limited range of motion at the knees, and could not abduct his arms. For the past year, he had experienced some epigastric distress, unrelated to food. He had no nausea or vomiting. His appetite was poor. He stated that for thirty-five years he had noted a bluish discoloration of the ears and sclerae but he had never observed any peculiarity in the color of the urine.

Physical Examination: The patient appeared to be suffering from some chronic disease. He stood with a decided stoop. His spine seemed to be fixed. His head was thrust forward and his arms hung limply at his sides. His knees were flexed. The skin, particularly on the head, neck, and chest, showed a peculiar mottled bluish and in some areas brownish pigmentation or discoloration. This pigmentation appeared to be most marked in the ears and at the tip of the nose. In the region of the small joints, particularly of the hands, were peculiar bluish linear discolorations which seemed to be beneath the skin.

The sclera were gray or slate colored, showing yellow-brown pingueculae 5 mm. to either side of the corneal edges. These areas varied from 2.5 × 5 mm. to 5 × 10 mm. Biomicroscopy revealed that the deeper layers of the sclera were pigmented and that the bulbar conjunctiva was unaffected, moving freely over the pigmented zones. In the superficial layers of the cornea near the temporal and nasal edges fine dark pigmented granules were observed. Vision of the right eye was normal. As stated above, vision was lost in the left eye, as a result of trauma.

Fig. 4. Case 1. Roentgenograms of ears showing distribution of the deposits.

The thyroid was not enlarged; the trachea was in the mid-line.

The chest was symmetrical, barrel-shaped, but expansion was poor. The lungs were clear. A rough hard systolic murmur was heard over the precordium, being most characteristic in the aortic area.

The liver, spleen, and kidneys were apparently not enlarged. No abdominal masses were palpable. The prostate was small, firm, and not tender.

The spine was rigid and there was a dorsal kyphosis with exaggeration of the lumbar lordosis. In the knees and shoulder joints, distinct crepitus was felt. There was practically no movement at the shoulder joints. The knees were held in partial flexion and extension was impossible. There was restriction of all movements at the hip joints. In the small joints of the hands and feet, there was some periarticular soft tissue swelling with slight limitation in motion.

Laboratory Data: The blood chemistry findings were as follows: serum phosphorus 4.5 mg. per cent; phosphatase 3.1 Bodansky units; non-protein nitrogen 32 mg. per cent; bilirubin, very faint trace; cholesterol 232 mg. per cent; protein 7.5 per cent; albumin 5.1 per cent; globulin 2.4 per cent; uric acid 5.1 mg. per cent. The urine was straw color; sp. gr. 1,020; albumin, very faint trace; glucose negative. It was positive to all tests for alkaptonuria, turning black on standing and on heating with Benedict's solution; it turned brown on alkalinization and blue on the addition of ferric chloride. Following the injection of liver extract, the urine for seventy-two hours failed to turn black on standing. At the end of that time, it again reacted positively to all qualitative tests for alkaptonuria. No quantitative determinations were performed. The red blood count was 4,400,000 and the hemoglobin 13.9 gm.; white blood cells, 5,000; polymorphonuclears 66 per cent; lymphocytes 30

per cent; mononuclears 2 per cent; eosinophils 2 per cent; Wassermann negative. E. K. G. was interpreted as sinus tachycardia; myocardial changes of the A2T2, Q3T3 type.

Roentgen Findings: The roentgen findings are shown in Figures 1, 2, 3, and 4.

Clinical Course: During his stay at the hospital, the patient was treated symptomatically. He was placed on a high-vitamin, high-protein diet and received 50 mg. of nicotinic acid twice daily. Physiotherapy in various forms was administered three times daily. For a period of two weeks, he was given 100 mg. of vitamin C daily. Although improvement in the general condition occurred, with relief of pain, he was finally transferred to a hospital for chronic diseases.

CASE 2: M. N., white male, married, aged forty-nine, was admitted to the clinic on the service of Dr. H. Finkelstein complaining of pain in the right knee joint and general weakness.

The patient was born in Turkey, one of nine children. Two of his brothers have voided black urine all their lives. Three daughters have the same disease. One of his grandchildren also voids urine which stains the diapers black.

The patient first visited the clinic eight years ago because of pain in the right shoulder, which had been present for years. The examining physician noted on the chart that there was some limitation of mobility of the shoulder joints, for which he ordered baking and massage. After six months' treatment, the disability had subsided to a considerable degree but the pain in the right shoulder was not relieved. Roentgenograms taken at that time were reported as demonstrating a slight hypertrophic arthritis in the cervical area. After some further treatment, the patient disappeared from observation. A urine examination was not made at that time.

On Jan. 18, 1938, the patient visited the office of one of us (I. S. T.) with a history of vague stomach symptoms which he then stated had existed since 1910. During a routine examination in the office, the urine was found to turn black on the addition of Benedict's qualitative solution. On persistent questioning, the patient admitted that he had been told that he had albumin and sugar in his urine and that fifteen years previously a physician had told him that he was suffering from alkaptonuria—a diagnosis subsequently confirmed at Mount Sinai Hospital. The patient was then referred back to the clinic of the Hospital for Joint Diseases.

Physical Examination: The patient appeared to be in a highly nervous state. He stood with a slight stoop, with knees flexed. He had a marked dorsal kyphosis and the lumbar lordosis was increased. There was a peculiar gray-blue discoloration of the head and neck and in numerous scattered areas over the body. The pigmentation appeared to be most marked in the ears and about the nose.

The sclera were slate colored. Brown pingueculae were present on either side of the corneal limbus. Biomicroscopy revealed pigmentation of the deeper layers of the sclera. The bulbar conjunctiva was unaffected. Pigmented granules were seen in the superficial layers of the cornea near the temporal and nasal edges. Visual function was unaffected.

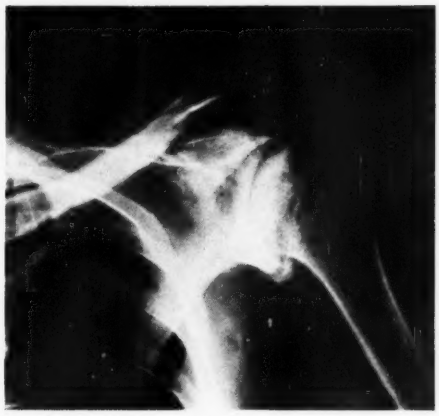


Fig. 5. Case 2. Narrowing of shoulder joint with marked eburnation of head of humerus and glenoid; large osteophyte in lower rim of glenoid fossa. There are no deposits in the subacromial bursa.

There was no enlargement of the thyroid. The trachea was not retracted.

The chest was symmetrical, hyperresonant with emphysematous breathing. The heart sounds were normal. There was no cardiac enlargement.

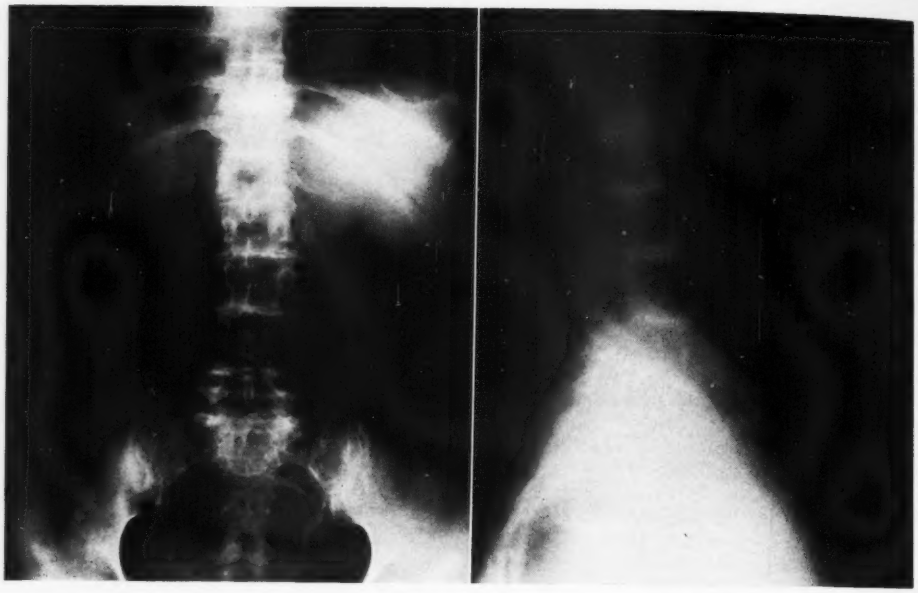
There was slight tenderness in the upper right abdominal quadrant, but no masses were felt.

A dorsal kyphosis was present. The spine was held rigid and all movements were so limited as to be almost completely absent. Abduction of the shoulders was limited to 90 degrees; external and internal rotation was restricted. There was marked limitation of external and internal rotation of the hip joint, the right hip being worse than the left. A periarticular swelling was present in the right knee; effusion was felt in the quadriceps pouch. The angle of greatest extension for the right knee was 160 degrees, for the left 180 degrees. The angle of greatest flexion for the right knee was 100 degrees, and for the left normal. The elbow, wrist, and ankle joints appeared to be normal.

Laboratory Data: All tests for alkaptonuria were positive. The Wassermann test was negative.

Roentgen Findings: The roentgen findings are shown in Figures 5, 6, and 7.

Clinical Course: The patient is not co-operative and visits the clinic infrequently, usually for the treatment of his arthritis. He presents the picture of a progressive ankylosing arthritis of the spine, and to a lesser degree of his shoulder and knee joints.



Figs. 6 and 7. Case 2. Narrowing of intervertebral joints with calcification of the cartilage; extensive calcification of costal cartilages. The lateral view shows the calcification of the intervertebral cartilages and spinal ligaments posteriorly.

CONCLUSIONS

1. The triad, alkaptonuria, ochronosis, and arthritis, represents a clinical entity which has its genesis in a rare metabolic anomaly.

2. Roentgenograms of a typical case display extensive calcification of the intervertebral discs with ankylosis of the spine. Similar calcifications occur in tendon sheaths, bursal sacs, and in synovial membranes.

3. Two cases of this disease are recorded, in one of which the diagnosis of alkaptonuria was made solely from the roentgenogram.

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DISCUSSION

W. J. Zeiter, M.D. (Cleveland, Ohio): It has been most interesting to hear this presentation on the rather rare occurrence of alkaptonuria, ochronosis, and arthritis. Clinically, one encounters this disease very rarely. Nevertheless, the characteristic urinary findings should call it to mind. A change

in the color of the voided urine to brown or a very inky black on standing, or after an alkali is added, is of clinical significance. This may be the only finding in these patients.

One case of alkaptonuria has been seen at the Cleveland Clinic, by Dr. R. L. Haden, and the diagnosis was made upon the urinary findings. The patient was a fifteen-year-old girl who complained of severe arthritis. The symptoms began at about the age of thirteen and first involved the terminal joints of the fingers and the second joint in the thumbs. Later the involvement spread to the big toe joints, ankles, and into the knee. At first the joints were swollen and stiff. As the condition progressed, ankylosis occurred, especially in the big toe joints and the thumbs. The patient had not noted any color changes in the urine. It was found, however, to become darker on standing for a time, and when alkali was added it turned very black. The patient's skin was much darker than that of her brothers and sisters, but there were no discolorations. The x-ray findings did not show the striking changes in the large joints that were observed in the cases just reported, involvement being confined to the smaller joints. In some areas the picture closely resembled that seen in gouty arthritis, with more or less punched out areas.

This unusual disease presents a very interesting picture. In the presence of positive urinary findings the diagnosis should be easily made.

Roentgen Therapy in Tuberculous Cervical Lymphadenitis[1]

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THE PURPOSE OF this communication is to re-emphasize the value of roentgen rays in the treatment of tuberculous cervical lymphadenitis and to present statistics on an additional group of irradiated patients to support the contention that this time-tested therapeutic agent can be regarded as one of the best single agents, and, in conjunction with well guided surgery, the most practical remedy in the management of this distressing disease.

Bergonié and Terrier (1898) have been credited by Pfender (14) with being the first authors to mention roentgen rays in the treatment of "scrofula." Hanford (8) and Reeves (16) give credit to Dawson-Turner (1902) for being the first to publish good results by this method of treatment. In 1902, Williams (19), of the Boston City Hospital, reported in his book that even the largest lymph nodes responded surprisingly well to treatment with the roentgen ray. Pusey and Caldwell (15) in the same year reported favorable response to multiple exposures in a case of scrofuloderma. Pfahler (12) in 1903, Bullitt (3) in 1905, and Boggs (2) in 1907 were among other early workers to report encouraging results following radiotherapy of tuberculous lymphadenitis. The literature of more recent years (6, 9, 13, 17, 18) indicates that roentgen irradiation has been well established as one of the most important therapeutic agents in this disease. In a small proportion of cases the rôle of conservative surgery either as the sole therapeutic measure or, as is more often the case, in combination with roentgen therapy, cannot be underestimated.

In 1922, Lahey and Clute (10), reporting on the end-results of surgical treatment of 48 cases, classified 43.4 per cent as excellent, while 28.8 per cent resulted in paralysis of the trapezius muscle. They stated that surgery should not be resorted to until x-ray therapy had been tried for at least a period of six months to a year. In 1927, Clute (4), discussing the surgical management, indicated that the best results were obtained in patients who came early for treatment because complete excision of the nodes was possible. If sinuses and abscesses were present, the chances of complete cure were not as good. He stated, also, that, "we have come to believe that postoperative x-ray treatment in all patients with tuberculous glands of the neck is of definite value." In 1940, Lahey, Hare, and Haug (11) showed statistically that 80 to 90 per cent of patients will respond to irradiation to such an extent that radical operation will prove unnecessary. These authors also stated that operation undoubtedly is the most rapid method of eradication, but that it leaves a poor cosmetic result and that later the percentage of recurrence is higher than when irradiation is employed. Hanford (7, 8) in a series of 141 patients obtained satisfactory results in 70.9 per cent. He stated: "I believe that the surgical procedures have played but a minor part in the results presented. It is fair to state, therefore, in studying the clinical course of 141 patients, that the roentgen ray was the predominating specific therapeutic agent employed."

TECHNIC AND DOSAGE OF ROENTGEN THERAPY

Since tuberculous cervical lymphadenitis is an inflammatory process usually of marked chronicity, the rationale for treatment adopted in this series took into account the fact that the inflammatory element could be controlled by relatively small doses of roentgen rays (Desjardins, 5) and that the chronicity factor could be

[1] From the Department of Roentgenology, Cleveland City Hospital and School of Medicine, Western Reserve University. Read before the Radiological Society of North America, at the Twenty-sixth Annual Meeting, Dec. 2–6, 1940.

managed by multiple exposures at relatively long intervals and continued over a considerable period of time. Thus, the multiple assaults on the varying phases of inflammation over a number of months would give the best chance for regression and healing of the involved nodes. This concept proved to be true in a large percentage of cases, as will be shown in the reported series.

The following physical factors were arbitrarily selected: 200 kv. potential with 0.75 mm. Cu plus 2.0 mm. Al filtration (H.V.L. of 0.9 mm. Cu), 50 cm. target-skin distance, a fractional dose of 150 roentgens (measured in air) every ten days for a period of 100 days, or a total dosage of 1,500 r (150 r × 10). Using 20 milliamperes of current, the output amounts to 35 r per minute. When the lesions are bilateral, 100 r are applied to each side of the neck at the same sitting and the total dosage is carried to 1,000 r (100 r × 10) to both cervical regions in a period of 100 days. The exit dose in this instance increases the direct dose in proportion to the thickness of the patient's neck, so that the total dose closely approximates that given to the unilateral lesion. The size of the irradiated field varies with the extent of the lesion, but is always made larger than the involved area. A modern, flexible, ray-proof, shock-proof tube-head is used which permits of easy angulation to accommodate almost any comfortable position the patient may assume while lying on the treatment table. Cones or cylinders may be employed for localizing the beam of rays, but these devices have not proved to be of any particular advantage over the open portal, the size of which is controlled by a lead diaphragm. In those patients whose lesions extend from the supraclavicular to the upper cervical region, the concavity in the lower neck allows the entire field to receive approximately an equal amount of radiation since the target-skin distance at the periphery of the field approximates that at the center.

The time-intensity factor (150 r every ten days × 10) precludes any possibility of skin damage even if the series were to be repeated six months or a year later. Experience has shown, however, that second and third repetitions may be dangerous to the skin. Only one patient in the present series developed atrophy and telangiectasis following the application of four courses of treatment in a period of two and a half years.

While this concept of time-intensity factor was independently utilized in this series of cases, it is not considered original. Review of the literature reveals that many workers in this field arrived at similar conclusions after experience had taught them that the best and safest results were obtained in this manner. Albert-Weil (1) (1917) applied roentgen rays filtered through 4 mm. Al in a series of treatments lasting several months. Hanford (8) and Reeves (16) used one-third of an erythema dose every two weeks for a total of ten treatments. In Hanford's (8) series of 141 patients, the number of treatments averaged nine. The plan used by Lahey, Hare, and Haug (11) was to give six to eight treatments in all, the first two a week apart and the others at three-week intervals. The number of treatments depended upon the individual response to irradiation.

In the present series, the response to irradiation was so rapid in some instances that the lesion was hardly palpable after the second or third exposure. In the majority of cases, the response was slower. Regardless of the rate of response, the plan was to administer a total of ten treatments.

RESULTS OF TREATMENT

The present study comprises 108 consecutively irradiated patients from 1932 to 1940, inclusive. All types of tuberculous cervical lymphadenitis were treated. These types included (1) the small isolated firm nodule, (2) multiple firm nodes of various size, (3) large firm masses composed of a conglomeration of small and large nodes, (4) small and large fluctuant

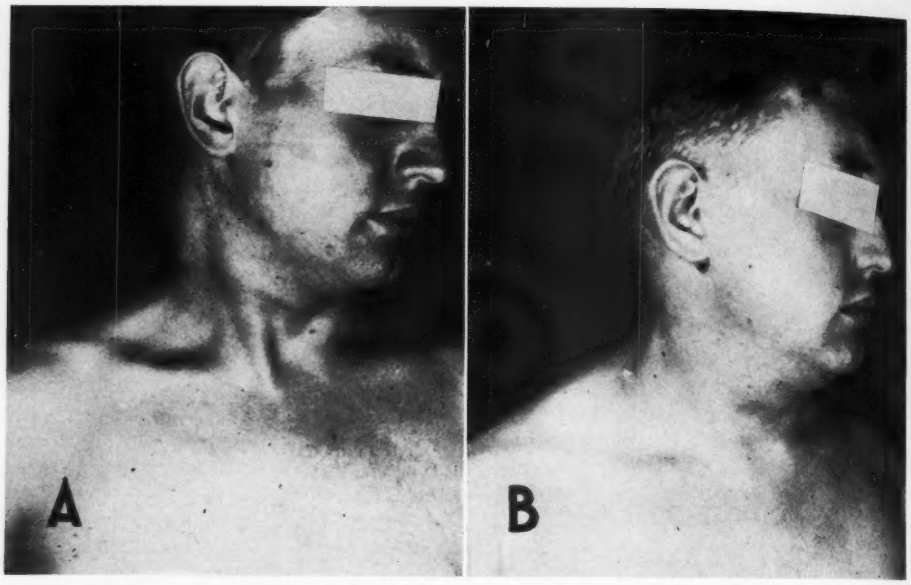

Fig. 1. Case 1: A. Jan. 11, 1940. Large swelling involving right upper deep cervical chain of lymph nodes before institution of roentgen therapy.
B. Nov. 1, 1940. Complete regression of tuberculous lymphadenitis and closure of draining sinus following roentgen therapy.

masses, and (5) any variety with a draining sinus. Since biopsy material was obtained in only about one quarter of the cases no attempt at histologic classification was made. Fourteen patients were excluded from this study because they received only one or at most two treatments. This amount of radiation was considered inadequate for evaluating the efficacy of this therapeutic agent. Of the 94 cases remaining, the majority (67 per cent) received a course of ten exposures. Satisfactory follow-up observation from a few months to seven years was carried out in 87 patients, 7 having been lost to observation.

The results of treatment are arbitrarily classified as satisfactory and unsatisfactory. Patients with satisfactory results are defined as those whose lesions underwent approximately 50 to 100 per cent regression (either during the course of treatment or within a few months following the last exposure), who were relieved of symptoms if any were present originally (such as pain, tenderness, or draining sinus), and whose deformity disappeared or was considered negligible. Many of the smaller lesions, 1.5 to 3.5 cm. in diameter, diminished to about half their original size so that only a small painless "kernel" remained. This type of response is considered a cure by most writers on this subject. All cases not falling in this category were classified as unsatisfactory results, even though some of them were greatly improved symptomatically.

Of the 87 patients with follow-up observations, 77 (88.5 per cent) were classified as showing satisfactory results and 10 (11.5 per cent) were considered unsuccessfully treated.

In this group of 87 patients 39 were Negroes, 37 white, and 1 of the yellow race. The age incidence ranged from 21 months to 64 years, the average being 22.5 years. The sex distribution was not remarkable, since there were 41 males and 46 females. Both sides of the neck were involved and treated in 32 patients, only one side in 53 (right, 31; left, 22) and the submental region in only 2 patients. The size of the

Fig. 2. Case 2: A. Large masses of tuberculous lymph nodes involving left side of neck extending from mandible to clavicle. No regression followed two courses of roentgen therapy.
B. Antero-posterior roentgenogram showing irregular calcification in tuberculous lymphadenitis.

lesions was recorded in 26 patients, the extent varying from one or two small nodes to the whole cervical chain and from 1.0 to 10.0 cm. in greatest dimension. Positive biopsy specimens were obtained in 24 patients. The remaining cases were diagnosed on a clinical basis. Draining sinuses were present in 22 patients, a few having been the result of surgical incision. All were controlled with one exception, in a patient in a far advanced stage of pulmonary tuberculosis before roentgen therapy was started. The sinus in this case was the result of incision; roentgen therapy was started three weeks later, and the patient died of miliary tuberculosis of the lungs after receiving only six treatments. Pulmonary tuberculosis of various stages was present in 21 of the treated patients.

ILLUSTRATIVE CASES

The following two case reports are representative of the satisfactory and unsatisfactory results obtained from roentgen therapy:

CASE 1: E. R. (212851), a white male, aged 26, was admitted to the Tuberculosis Division on Sept. 13, 1939, with a diagnosis of moderately advanced pulmonary tuberculosis. Sputum examinations were positive for tubercle bacilli and roentgen studies of the chest demonstrated parenchymal infiltration in the middle third of the left lung field. In October 1939, the patient developed a group of enlarged lymph nodes in the upper posterior cervical chain on the right (Fig. 1-A). This mass of nodes enlarged to 8 × 6 × 4 cm. during the next two months. The nodes were movable and the skin over them was not reddened.

High-voltage roentgen therapy was applied in 150 r fractions at ten-day intervals to a field 10 cm. in diameter from Jan. 11 to April 12, 1940. On April 11, the day before the last exposure, the lower end of the mass, being fluctuant, was incised and drained. The main bulk of the mass had almost completely disappeared at the end of the course, but drainage continued for several months. In September drainage ceased and there was less reddening around the opening of the sinus. By November 1940 there was hardly a semblance of the original nodes save for a slight degree of brownish pigmentation at the site of the old sinus (Fig. 1-B).

CASE 2: M. B. (184174), a white female, aged 40, was admitted to the Medical Service of Cleveland City Hospital on Feb. 20, 1938, with the complaint of "swollen glands." She stated that she had had enlarged, painless nodes in the left side of the neck since fourteen years of age. For two years prior to admission, the nodes became progressively larger, and a new group of nodes appeared in the left axilla.

The latter became tender and grew rapidly in size during the six months' period before admission. There was a loss in weight of 20 to 25 pounds. At this time, some dental root abscesses and pyorrhea alveolaris developed, necessitating removal of all the teeth.

Physical examination showed the left cervical adenopathy to consist of discrete and firm nodes, the masses ranging from 1.5 to 5.0 cm. in diameter. The upper anterior mass measured 5 × 3 × 3 cm.; the lower posterior mass was 4 × 4 × 3 cm. (Fig. 2-A). The mass of nodes in the left axilla measured about 6 cm. in diameter. The spleen, which could be palpated 2.5 cm. below the costal margin, was firm and non-tender. A roentgenogram of the chest made on Feb. 3, 1938, showed evidence of old healed and calcified tuberculous foci in both hili and subapical regions. Similar calcifications were present in the left supraclavicular and cervical regions (Fig. 2-B). A biopsy specimen taken from the left axillary nodes proved on microscopic examination to be tuberculous lymphadenitis. On consultation, the phthisiologists and surgeons agreed with the diagnosis of tuberculous cervical and axillary lymphadenitis and recommended roentgen therapy.

High-voltage roentgen rays were applied in fractions of 150 r every ten days to a 12 × 10 cm. field in the left cervical region and in the left axilla, from Feb. 21 to May 23, 1938. There was gradual improvement constitutionally, in that the temperature, which had fluctuated between 37.5 and 38.5° C. from admission to March 1, had dropped to 37.5° at the time of discharge from the hospital, March 11, following the first three roentgen exposures. There was no appreciable diminution in the size of the cervical and axillary masses. In August of the same year a second course of roentgen therapy was instituted from Aug. 22 to Nov. 23, with the same technic.

At the last observation, on Sept. 9, 1940, the nodes in the neck were still hard, painful, and tender, showing practically no regression in size. The nodes in the left axilla had largely disappeared.

Comment: Case 1 typifies the ideal response to irradiation, even though incision and drainage were necessary when the mass became fluctuant. Regression and healing of nodes and sinus were so complete that hardly a trace of the original lesion could be detected ten months after the beginning of the treatment. While Case 2 represents a failure of local healing, there is no doubt that the patient was greatly improved from a constitutional standpoint. The fact that the nodes had been present for twenty-six years before treatment was instituted may be an important factor in the failure to control the local disease. No further irradiation is contemplated in this patient because of the danger of producing a radiodermatitis.

Of the other 9 patients in which the treatment was considered unsuccessful, two had far advanced pulmonary tuberculosis, one had extensive involvement of the parotid gland by tuberculous abscess formation, one had a draining sinus which healed without regression of the mass of nodes, in one complete regression was followed by recurrence at the same site four and one-half years later, and in four no particular related factors were found to account for the lack of regression.

SUMMARY AND CONCLUSIONS

(1) Roentgen rays, in conjunction with conservative surgery, may be regarded as one of the most practical remedies in the management of tuberculous cervical lymphadenitis.

(2) The early literature contains encouraging reports on the effects of roentgen rays on tuberculous lymph nodes.

(3) The patients of the present series received treatment with conventional high-voltage roentgen-ray apparatus. In unilateral cases, 150 r are applied once every ten days for ten treatments. In bilateral cases, the dose at each sitting is 100 r to each side of the neck.

(4) The rationale of the time-intensity factor is emphasized.

(5) A study of 87 unselected irradiated patients demonstrates the results to be satisfactory in 88.5 per cent and unsatisfactory in 11.5 per cent.

(6) Two cases are reported in detail to illustrate types of satisfactory and unsatisfactory results in roentgen therapy of tuberculous cervical lymphadenitis.

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DISCUSSION

F. T. Moore, M.D. (Akron, Ohio): Dr. Hauser's paper is so well worked out that it calls for very little discussion. I don't think any of us would differ greatly from him in the handling of these cases.

This is another entity that has been shifted from surgery to radiation therapy by results alone. I think the end-results are so uniform and so predictable that one is privileged to question the diagnosis of those cases that do not respond.

For example, in our service, I know of one case that did not respond even though the biopsy report was tuberculosis. A second biopsy revealed lymphosarcoma.

Karl Kornblum, M.D. (Philadelphia, Pa.): I should like to ask Dr. Hauser if he knows whether there are any autopsy statistics to indicate the percentage of tuberculous glands in the neck as compared with enlargement of glands from other causes.

John D. Osmond, M.D. (Cleveland, Ohio): Just as a matter of interest, we have treated our cases of cervical adenitis with the so-called nine-inch therapy rather than deep therapy. Many years ago Dr. C. A. Hamann referred a patient to me upon whom he had operated four times, with repeated recurrence. I gave her about three exposures of the nine-inch therapy using 3 mm. aluminum filter, 10 in. distance, 5 ma., 5 minutes for each treatment. The nodes subsided and did not enlarge again, and Dr. Hamann declared he would never operate in another case of tuberculous adenitis.

Harry Hauser, M.D. (*closing*): In answer to Dr. Kornblum's question, I do not know offhand of any autopsy statistics comparing tuberculous cervical lymphadenitis with other types of lymphadenitis.

The Effect of X-ray Therapy for Closure of the Epiphyses: Preliminary Report[1]

DAVIS SPANGLER, M.D., F.A.C.R.
Dallas, Texas

LEGS OF unequal length are a serious handicap and the prevention and cure of this deformity constitute a major orthopedic problem.

Phemister (5) gives six causes for unequal length during the growing period: fractures with overriding fragments or obliteration of the epiphyseal line; joint infection destroying adjacent epiphyses; bone infection causing loss of bone or fusion of epiphyses (occasionally causes lengthening due to stimulation); bone tumors at ends of shafts of growing bones; congenital disturbances; infantile paralysis. The shortened leg must be compensated by pelvic tilt and spinal curvature, or by an elevated shoe on the affected leg, or corrected by operation.

Since short legs of nearly equal length are preferable to legs of unequal length, various surgical methods have been advocated for correcting the inequality: Abbott's leg lengthening; Ferguson's drilling of the diaphysis to stimulate growth in the affected leg; shortening of the healthy femur at the end of the growth period; and Phemister's and later White's (9), operation for closure of the epiphyses around the knee in the normal leg. This latter procedure is the more sensible, as 60 per cent of leg growth occurs at the knee epiphyses and the operation is performed in the more healthy tissues. There is some postoperative morbidity in any of the surgical procedures and infection may develop even with the best technic. There is also the possibility of fusion of only one side of the epiphysis with resultant deformity from asymmetrical growth.

The estimation of future growth of the affected leg is a problem to be solved by the

Figs. 1 and 2. Case 1: Before irradiation of normal epiphyses (left) and one year later (right), showing epiphyseal closure following treatment. See also Fig. 3.

[1] Read before the Radiological Society of North America at the Twenty-sixth Annual Meeting, Cleveland, Ohio, Dec. 2–6, 1940.

orthopedist. Obvious fusion of the epiphysis from injury or local infection means no further growth. Retardation of growth from poliomyelitis and congenital faults requires repeated observation and expert judgment to determine the time and type of therapy required.

Desjardins (3) in 1930, Stevens (8) in 1935, and Bisgard and Hunt (1) in 1936 called attention to the danger of radiological treatment of tumors in the region of epiphyseal lines, each reporting subsequent deformities due to premature closing of the epiphysis as a result of the irradiation. Bisgard and Hunt (1) conducted experiments on the bones of growing rabbits to determine more clearly the cause of this retardation or stoppage of growth. They reached the following conclusions.

"The shaft of a bone can be irradiated with 1,500 r at 0.50 Ångström unit, without causing a disturbance of growth providing the epiphyseal cartilages are protected from direct action of the rays. . . .

"In young rabbits, a single dose of 400 r, or a dose about equal to that required to produce an erythema in man, caused slight retardation of epiphyseal growth in long bones. . . . it is possible that cartilage is more radiosensitive in the rabbit than in man.

". . . it may be deduced that . . . epiphyseal cartilage is more radiosensitive than skin, and that . . . an erythema dose over an epiphysis in a child carries with it the danger of retardation of growth.

"Fractionation of the total dosage of x-rays, and protraction of the interval between the fractionated units, greatly lessens the effect upon growth. . . .

"All evidence indicated that the action of x-rays upon cartilage cells is solely destructive. . . .

"It is obvious that individual cartilage cells vary considerably in respect to radiosensitivity."

Brooks and Hillstrom (2) from their animal experiments conclude:

"All animals receiving 40 per cent or more of the skin erythema dose showed definite inhibition of bone growth. . . . In general, it may be said that immediately after exposure of the epiphyseal cartilage to the standard 100 per cent S.E.D., there is marked evidence of serious damage to the cartilage cells. The arrangement of the cells becomes irregular. Some cells are swollen and others are obviously disintegrated. Some cells appear normal and are regularly arranged. The irregularity of arrangement persists throughout the entire period of bone growth. . . . During the latter part of the period of bone growth, the epiphyseal cartilage becomes irregular in thickness. In some instances, the cartilage disappears completely in some areas. It is particularly during this period that growth deformities develop."

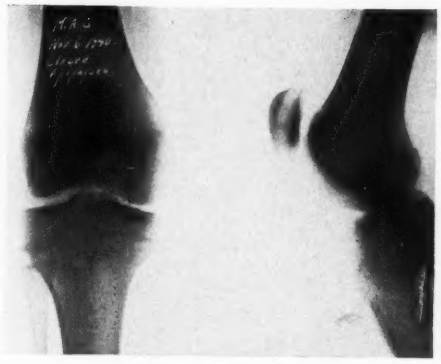


Fig. 3. Case 1: Roentgenograms made twenty-one months after those reproduced in Fig. 2. There is no evidence of bone degeneration as a result of irradiation.

Regen and Wilkins (7) gave 2,600 r in one dose to rabbits, causing loss of hair with its later return. They say:

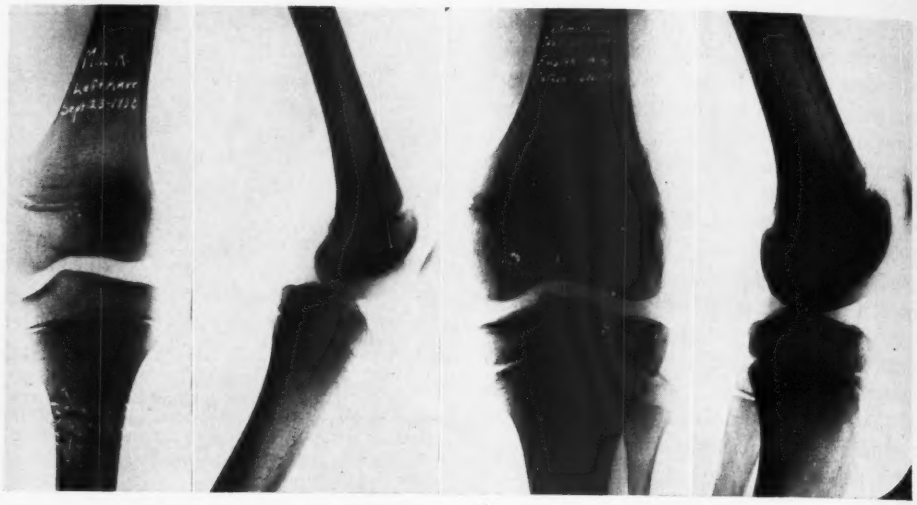
"These findings show quite definitely that bone growth, as judged by length, can be completely stopped by exposure to a sufficient dose of x-rays, and that up to maturity of the skeleton, no reappearance of growth occurs."

Pohle (6) warns that:

"In irradiating young people care should be taken not to give heavy doses . . . to the epiphyseal junctures. Two or three doses of 540 r (in air) each will cause permanent shortening of a limb owing to the checking of the growth at the epiphyseal juncture."

With these facts and warnings at hand, it occurred to us that deliberate closure of the epiphyseal lines of bones around the normally growing knee might be brought about with the x-ray. This retardation, if accomplished, would serve the same purpose as the Phemister and White operations without their practical and theoretical disadvantages. This procedure would permit the shortened leg to attain more nearly the length of the good leg.

With the permission and co-operation of Drs. W. B. Carrell and P. M. Girard, four children with unequal legs from the Scottish Rite Hospital for Crippled Children



Figs. 4 and 5. Case 3: Before irradiation of normal epiphyses (left) and eleven months after fusion operation by White hollow chisel method (right). Roentgen therapy inadequate. See Fig. 8.

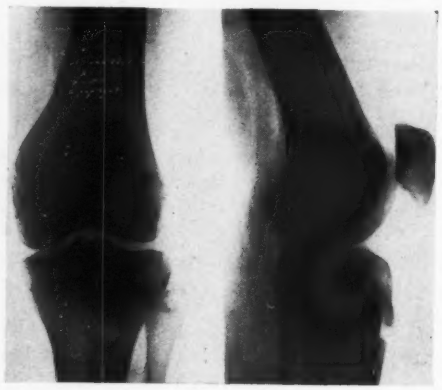


Fig. 6. Case 4: Fusion of normal epiphyses after beginning roentgen irradiation.

were given x-ray therapy over the healthy knee in an effort to close the epiphyses.

CASE REPORTS

CASE 1: Marie Ann G. was first seen Dec. 21, 1932, when 6 years of age. At 8 months of age she had infantile paralysis with involvement of the right leg, which now showed atrophy and shortening.

The child was seen about every six months, the difference in leg length increasing until February 1936, when the left leg was 5 cm. longer than the right. The sole of the right shoe was elevated, so that there was no pelvic tilt or spinal curvature. In February 1936, a Ferguson drilling around the right lower femoral and upper and lower tibial epiphyses was done in an effort to stimulate their growth.

In April 1938, when the patient was 12 years old, the left leg was 4.5 cm. longer than the right. At that time x-ray therapy was begun. Four areas around the left knee were treated as follows, a narrow strip of lead protecting the joint cartilages: April 28, anterior and mesial area; April 29, lateral and posterior areas; April 30, anterior and mesial area; May 2, lateral and posterior areas. The factors were 170 kv., 0.25 mm. Cu and 1.0 mm. Al, 16.6 r per minute (in air). Total 2,656 r in air. Roentgenograms, Feb. 1, 1939, indicate closure of the epiphyses.

In May 1940, there is still 5 cm. shortening, but the epiphyses are closed in the left leg.

CASE 2: Wilbur L. G., 11 years old, was admitted March 2, 1938. At 15 months of age he had an illness with increased temperature and stiff neck, followed by paralysis residual in the right lower extremity. He had occasional chiropractic treatments. The right leg was 4.2 cm. shorter than the left. The diagnosis was old poliomyelitis, residual in right leg and foot.

X-ray treatments were given over the left knee as follows: March 9–12, 1938, 1,245 r, 170 kv.; Nov. 17–18, 1938, 672 r, 140 kv.; Jan. 18–19, 1939, 588 r, 140 kv.; March 8–9, 1939, 588 r, 140 kv.; June 7–9, 1939, 588 r, 140 kv.; Aug. 30–31, 1939, 672 r, 140 kv. Total, 4,353 r in air.

The child was seen about every six months. The difference in leg length remained about constant. On March 8, 1939, the epiphyses showed evidence roentgenographically of beginning closure. Roentgenograms on Aug. 30, 1939, showed no change from the previous ones and a second x-ray series was given.

On Nov. 24, 1939, because of child's age and the incomplete fusion on plates, the lower femoral and upper tibial and fibular epiphyses were closed by

Fig. 7. Normal epiphyseal cartilage.

Fig. 8. Insufficiently treated cartilage, Case 3.

Fig. 9. Cessation of growth after adequate irradiation, Case 2.

the Phemister method and a small piece was taken for study. The pathologic report was as follows: "Osteochondral junction following x-ray therapy. The cartilage cells are elongated. There is an abrupt transition from cartilage to bone with no intervening evidence of growth activity. Herschel Penn, M.D. (4)." This proves physiological closure (cessation of growth) without enough change to be demonstrated by roentgenographs.

In March 1940, there was 10 per cent limitation of motion in the left knee; no pain on motion. On May 29, 1940, only 2 cm. difference in leg length was found.

CASE 3: Mary Lou R. was first seen Dec. 14, 1932, when 3 years old, with 2 inches (5 cm.) shortening of the left leg due to a congenital defect in the formation of the leg. In October 1933, a Ferguson stimulating operation was performed on the lower end of the left femur and the upper and lower ends of the left tibia and fibula. Between October 1933 and March 1938, the difference in the length of the legs reached 8 cm.

On March 28, 1938, eight areas received x-ray treatments: 1,992 r in air, 170 kv., 0.25 mm. Cu and 1.0 mm. Al filtration. On Sept. 23 and 24, 1938, four areas were treated, receiving 672 r.

Roentgenograms in January, July, and November 1939 showed the epiphyses unfused. On Dec. 4, 1939, White's hollow chisel method of closure of the epiphyseal lines was carried out in the right lower femoral and upper tibial and fibular epiphyses.

On July 17, 1940, at 11 years of age, there is 7.9 cm. shortening of the left leg.

CASE 4: Dorothy K., aged 8 years, was admitted to the Scottish Rite Hospital in March 1935. In July 1933, she had a boil on the right elbow, followed three days later by high fever and pain just above the right knee. The leg was incised and was still draining. A roentgenogram showed a large sequestrum in the lower half of the right femur, with osteomyelitis damaging the lower epiphysis. The right leg was 2 cm. shorter than the left. Sequestrectomy was done, the patient remaining in the hospital until June 1, 1935.

From March 1935 to April 1, 1938, when the patient was 10 years old, the relative shortening of the right leg increased from 2 cm. to 8 cm.

X-ray therapy was given from April to September 1938, a total of 4,330 r being given in divided doses. In September 1938 closure of the femoral and tibial epiphyses was seen.

In July 1940 the right leg was 10 cm. shorter than left.

SUMMARY AND COMMENT

Roentgen therapy—2,656 r given in four consecutive days in the case of Mary Ann G., and 4,300 r in divided doses in the cases of Dorothy K. and Wilbur L. G.—produced closure of the epiphyses, but 1,992 r in March and 672 r in September in the case of Mary Lou R. failed. This leads me to conclude that around 3,000 r given in one fractionated series will produce epiphyseal closure. The fractionation of the dose can be arranged as best suited to produce tanning, but not epidermitis. The knee joint cartilages should be protected with lead strips.

These children were treated at an age just preceding or during the puberty spurt of bone growth. I believe that more satisfactory results would follow treatment at an earlier age—say six to ten years—especially

if there be proved fusion of epiphyses in the short leg.

Of the 4 cases treated, 3 had epiphyseal closure—in two shown in roentgenograms and in one proved at operation. Roentgenographic proof of closure of the epiphyseal line lags far behind physiological closure, as was shown in Case 2.

This series is small as we are awaiting the outcome before deciding if, when, and where to fit this method into the orthopedic procedures of epiphyseal closure. It is not as rapid as the operative method, but it does have the advantage of producing uniform changes throughout the whole of the epiphyseal area.

NOTE: I wish to express my thanks to Drs. Carrell and Girard for the privilege of reporting these cases and to Dr. Herschel Penn of Knoxville, Tennessee, for his co-operation.

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DISCUSSION

James I. Kendrick, M.D. (Cleveland, Ohio): Dr. Ryan was scheduled to discuss Dr. Spangler's paper but he asked me to substitute for him, since mechanical factors seemed to be especially involved and a discussion from the orthopedic standpoint would appear to be more pertinent than from the endocrine standpoint.

Orthopedists are often faced with the problem of inequality in the length of the lower extremities. To compensate for such inequality the short leg can be lengthened or the long leg shortened. In order not to alter the stature of the patient, preference has frequently been given to lengthening the short leg. This is a major orthopedic procedure, and requires prolonged hospitalization and fortitude on the part of the patient, but in selected cases gives excellent results. Undoubtedly it will continue to have a place in the treatment of patients whose extremities are unequal in length.

Shortening the longer extremity is technically a less difficult procedure but patients usually speak of the longer extremity as their "good leg" and are reluctant to have an operation on it either for shortening it or for closing the epiphyses. If the procedure which Dr. Spangler has described proves to be both safe and effective, I think that it will be very useful. Methods have been devised for calculating the amount of growth which is expected to take place in the various epiphyses. By selective closing of one or more of these epiphyses in the normal or long leg, the length of the extremities can be controlled so that at the end of the growth period the extremities will be equal in length. Closure of the epiphyses by deep x-ray exposure is apparently both safe and effective, as shown by Dr. Spangler, and certainly is simple enough. More time and further experience will determine the ultimate usefulness of the procedure.

As to alteration in the height, this is of so much less importance than the disability from having legs of unequal length that if the matter is explained to the patient, he will readily accept the change in stature.

I am glad to have had the opportunity of discussing this paper. Dr. Spangler is to be commended for his work and presentation.

J. Robert Andrews, M.D. (Cleveland, Ohio): Dr. Spangler's work represents another adaptation of x-ray therapy to the alteration of physiological function. It occurred to me there is perhaps a confusion of terms. In other words, we are speaking of two different things: first, cessation of growth and, second, the closure of the epiphyses. It would seem to be unimportant whether or not we demonstrate closure of the epiphyses within a short or a long time if we have obtained the result of growth restraint.

Two of Dr. Spangler's four cases came to operation. If the operation was based merely upon the x-ray evidence of failure of epiphyseal closure, though growth had already ceased, then the operations probably were not necessary. If, however, neither the growth had ceased nor the epiphyses closed, it would appear that treatment was successful in only 50 per cent of the cases. I should like to have that point explained a little further.

R. R. Newell, M.D. (San Francisco, Calif.): Whether a patient should have the limbs equalized,

whether it should be done by lengthening the short leg or shortening the long leg, when it should be done, and whether by stopping the growth of the long leg, are orthopedic problems that need not be thrashed out before this meeting. The radiologist until the moment of that decision has a diagnostic function. He can measure the length of the limb. This should be done at intervals so that the orthopedist may have a growth curve to permit a prediction, in the case at hand, in connection with his standard tables of epiphyseal growth. These measurements should be done very precisely. There is too much enlargement even in a six-foot roentgenogram to make a really precise measure of the length of bones. Both limbs should be measured together, with the film under both thighs (then both legs); a small cone picture is taken at one end of the limb with x-rays strictly vertical; the tube is then moved and the picture at the other end of the limb is taken with x-rays strictly vertical. Under these circumstances records of the length of the limb are obtained without magnification and are quite dependable.

As to stopping the growth, there are two problems here. Can growth be stopped and is it dangerous? Undoubtedly growth can be stopped, but one can't choose the moment by the time of maximum radiosensitivity. It must be chosen by timing the interruption to obtain the right length at the end. As to the danger: When we are treating cancer, we all know we are trying to save the patient from a presumably fatal disease and there is no great criticism of tissue injury; here we are concerned with a very different matter and the specification of a safe dose must be done minutely. We cannot have any 50 per cent uncertainty in the dosage if we are to rest on the experience of others as to what is safe.

One of my pet hates is specification of dosage which doesn't mean anything. There are reports about cases of cancer which have been treated with 12,000 roentgens; 2,000 roentgens given to six different areas are added together, to give 12,000. This means nothing. If the roentgens given to different fields are going to be added together, it can be done only in terms of tissue dose in some named position. Adding the separate fields together doesn't mean a thing. If you don't know your tissue doses, entrance and exit, or don't trust the physicist's tables, or don't like arithmetic, then don't try to add up your doses at all, but limit your statement of dosage to how much was applied in air to each field and let each of us who reads your report try to figure it out for himself.

Davis Spangler, M.D. (*closing*): I stand corrected on the method of estimating dosage. My recommendation is four portals—one anterior, one posterior, and one through each side, centered at the knee joint. These are given 750 r each, 140 p. kv., through 0.25 mm. Cu. The dose should be fractionated, with treatments given to two areas daily to produce a mild first-degree erythema with later tan. The dosage is high because we are attempting to destroy the function of normal healthy growing tissue. The length of the portal is about 12 cm.

This treatment has been more or less empirical and has been given with fear and trembling. I did not know what was going to happen and was trying to find out. I am bringing this to your attention, hoping that some of you will use the method.

Dr. Newell's method for measurement of leg length is excellent. White has recently given a very practical method of estimating the difference of leg length by roentgenographs of the pelvis (White, J. W.: South. M. J. **33:** 946–949, September 1940).

I agree that the time and method of treatment are the orthopedists' problem. This work has been done in conjunction and in co-operation with the Orthopedic Staff of the Scottish Rite Crippled Children's Hospital in Dallas. I do not know that we will continue this method; final results will tell. I have seen each of these children during the past month and could find no evidence of soft tissue change or damage. Carefully made roentgenographs show no change in bone trabeculation from the normal. There was no bone absorption or osteoporosis and it is now nine months since the last treatments.

Cases in which the growth in the short leg has been definitely stopped by infection of or fracture through the epiphyseal line are ready for x-ray closure of epiphyses in the normal leg whenever the orthopedist desires. In case of congenital anomalies and poliomyelitis, where there may be slight growth in the affected leg, the orthopedist must assume responsibility as to age of beginning treatment.

In one of our cases operation was done because we were estimating the efficacy of the x-ray therapy by the calcification seen in the epiphyseal lines. As I have shown, calcification lags far behind the cessation of growth in this particular tissue. Hence, the presence of calcified epiphyseal line proves closure; but delayed calcification does not mean continued growth. I am firmly convinced that the therapy recommended will stop epiphyseal growth.

With the use of the four portals, there will be a uniform effect throughout the whole cartilage, as in few instances will the knee exceed 10 cm. in diameter. This should eliminate irregular growth, which may follow surgery. I feel that the articular cartilage should receive some protection with a lead strip about 1.5 cm. wide, with its upper edge at the lower border of the patella. Articular cartilage may be more radioresistant, but there is no need to chance this.

Our final results are still doubtful, as it has been only two years since treatment of these cases. This has been an effort to produce a physiological change in normal healthy cartilage, which, so far as I know, has not previously been reported as being done in man.

Roentgen Irradiation of Calcareous Deposits About the Shoulder[1]

L. W. BAIRD, M.D.

Temple, Texas

SINCE THE appearance of Codman's original article on subdeltoid bursitis, many contributions have been added to the literature on this subject. Considerable controversy has arisen as to the exact location of the calcium deposits, but most authors are of the opinion that the deposits originate in the tendons and tendinous tissues, the bursa being involved secondarily with an inflammatory reaction but usually not containing calcium.

This report covers a clinical and roentgenologic study made at the Scott and White Clinic from 1937 to 1940, of 44 patients in whom calcium deposits were demonstrated about the shoulder. The results of roentgen therapy in 18 of these patients who have been under close observation are presented.

ETIOLOGY

The etiology of this pathologic condition is still obscure. Repeated trauma, over-use or unaccustomed uses of the arm, focal infection, and endocrine and metabolic disturbances are a few of the many causes to which the disease has been attributed.

In this series of patients the right shoulder was involved in a ratio of 2 to 1 for the left. The age incidence varied between 25 and 76, the average being 42.5 years. Sex did not appear to play any significant rôle in the etiology, as both sexes were affected equally.

SYMPTOMS

The symptoms varied with the clinical stage of the disease, although in the majority of instances it was impossible to draw a sharp line of demarcation between the clinical pictures of the acute and subacute stages.

In the acute stage the symptoms occurred suddenly, with severe shoulder pain which radiated down the arm or into the neck region. An acute point of tenderness was present directly over the greater tuberosity of the humerus, This tenderness was accompanied by an acute spasm of the shoulder muscles with resultant restricted mobility (external rotation and abduction) of the shoulder.

In all patients studied, the temperature was normal or subnormal and the blood examination revealed no evidence of leukocytosis. The size and number of the calcareous deposits seemed to have no relation to the severity of the symptoms (Fig. 1).

The symptoms in the subacute stage or in the acute exacerbation of the chronic stage were very similar to those of the acute form, except that they were milder and usually of longer duration.

In the chronic stage, pain and tenderness were present only to a mild degree. The outstanding symptom was limitation of motion. This restricted mobility was different from that in the acute stage in that there was very little or no accompanying muscle spasm about the shoulder.

The quiescent stage represents in reality a chronic form of the disease in which calcareous deposits are demonstrable roentgenologically but are not accompanied by symptoms.

ROENTGEN DIAGNOSIS

In the majority of cases the calcareous deposits were visualized without difficulty although it is always advisable to make two exposures: one with external rotation of the humerus, as this presents the best profile view of the greater tuberosity, and the

[1] From the Department of Radiology, Scott and White Clinic, Temple, Texas. Read before the Radiological Society of North America, at the Twenty-sixth Annual Meeting, Dec. 2–6, 1940.

Fig. 1. *A*. Acute pain and tenderness with small calcareous deposit. *B*. Large calcareous deposit with very mild symptoms.

Fig. 2. Two views of the same shoulder. *A*. External rotation. *B*. Internal rotation. The calcareous deposit is not clearly visualized in *A*, and might have been overlooked had not roentgenograms in both positions been made.

other with internal rotation of the humerus (Fig. 2). Since deposits may occur bilaterally, it is advisable to make exposures of both shoulders, even though the symptoms may be unilateral. In the very acute cases it is often necessary to use a soft tissue technic in order to demonstrate the calcareous deposits, which cast a very faint shadow on the roentgenogram. Examination of the roentgenogram before a small bright spotlight will often bring out thin, hazy shadows in the acute cases which may otherwise be overlooked.

The calcareous deposits may be single

Fig. 3. Subacromial bursa, completely filled with calcareous material. Surgically proved.

or multiple, and in this series varied in size from 1 mm. to 36 mm. Their most common location was just proximal to the greater tuberosity but they were also found behind and in front of the glenoid cavity, near the acromium and coracoid processes, and in the neighborhood of the lesser tuberosity of the humerus.

The calcareous deposits had no definite structure. In the region of the greater tuberosity they were more often crescent shaped, similar to the course of the supraspinatus tendon, while shadows in different locations were of variable structure. One deposit cast a perfect shadow outline of the subacromial bursa (Fig. 3). Due to the close proximity of the anatomical structures of the shoulder, it is impossible in the majority of instances to determine the true anatomical location of these deposits roentgenologically.

DIFFERENTIAL DIAGNOSIS

There is no necessity in this presentation for discussing the differential diagnosis of painful lesions of the shoulder, as this can be readily accomplished by a careful history, physical examination, and roentgenography.

When calcareous deposits are visualized roentgenologically, it is not difficult to differentiate them from calcified blood vessels, lymph nodes, parasites or opaque media, and foreign bodies. More important in the differential roentgen diagnosis is fracture of the greater tuberosity of the humerus. This pathologic condition may simulate, in the roentgenogram, calcified subacromial bursitis, especially when the fractured tubercle is pulled upward by the attached supraspinatus tendon. Fracture of the tuberosity is always preceded by a history of trauma and is usually clearly visualized roentgenologically. If the fracture is not visualized, the trabecular markings in the fractured fragment will readily reveal the identity of the lesion, as the deposits in subacromial bursitis are calcareous and never true bone (Fig. 4). Post-traumatic myositis ossificans and various senile bony proliferations about the shoulder must be mentioned in the differential diagnosis. These pathologic lesions also form true bone, and careful scrutiny of the roentgenogram will reveal their bony structure.

Calcareous deposits are rarely present in rupture of the supraspinatus tendon, but whether the deposits are present or not, the diagnosis is clinical and cannot be made from the roentgenogram alone.

TREATMENT

Almost every conceivable form of therapy has been used in the treatment of this disease entity, including local heat, rest, physiotherapy, novocain injections, irrigation of the bursa, surgery, and roentgen irradiation. Good results have been reported by the advocates of each of the above methods of treatment.

It must be admitted that there is no specific form of therapy that is successful in all cases of subacromial bursitis. Most recognized methods of treatment today produce good results in the acute stage of the disease but rather disappointing results in the chronic stage. Since the economic

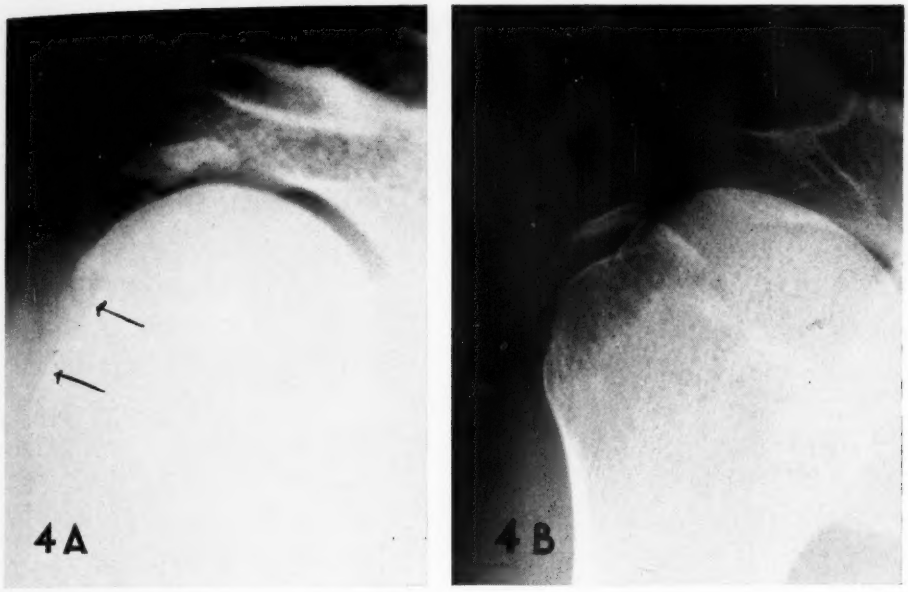

Fig. 4. Fracture of the greater tuberosity of the humerus. *A*. Fractured tuberosity clearly visualized (arrows). *B*. Actual fracture not so obvious; decreased density of the tuberosity is suggestive, but bony trabeculation in fragment reveals the true nature of the lesion.

factor in any disabling disease is important, the method of treatment which is capable of producing quick relief of pain and discomfort with complete restoration of normal function is the treatment of choice. In the 44 cases studied in this report several different types of therapy were used but roentgen irradiation proved to be the preferred method in the majority.

Roentgen irradiation has been used successfully in the treatment of this disease for many years. Lattman, Sandström, and Herrman have contributed excellent reports on this form of therapy. Although irradiation is not a panacea for calcified subacromial bursitis, it is easily and economically administered and in the majority of patients results in a complete cure.

Although the response to roentgen irradiation was approximately the same in this disease whether or not calcareous deposits were present, this report includes only cases with calcareous deposits, in an attempt to demonstrate some relationship between the character of the deposit roentgenologically and its response to therapy.

This series comprises 18 patients with calcified subacromial bursitis proved roentgenologically and treated by roentgen irradiation. Of these 18 cases, 9 were acute, 5 subacute, and 4 chronic. The technic used in treatment was as follows: 300 r (measured in air) in a single dose through a 15 by 15 cm. cone, angled slightly toward the body over the anterior-lateral portion of the shoulder. The central beam of radiation was directly over the acute point of tenderness. The physical factors were: 200 kv. (constant potential), 1.0 mm. Cu plus 1.0 mm. Al filter, 50 cm. distance, 18 ma. One treatment was given and this was repeated at intervals of three to four weeks when necessary.

Only one exposure was required to relieve the pain completely and restore normal function in the 9 acute and 2 of the subacute cases. In the majority of these patients the symptoms had entirely disappeared within seventy-two hours; the longest time before complete restoration of normal function was obtained was six days,

Fig. 5. Subacute stage of calcified subacromial bursitis, with complete relief of symptoms in six days following one exposure to roentgen irradiation. *A*. Roentgenogram before treatment. *B*. Roentgenogram made seventeen days after treatment, showing complete disappearance of the calcareous deposit.

Fig. 6. Acute stage of calcified subacromial bursitis, with complete relief of symptoms 36 hours following one exposure to roentgen irradiation. *A*. Before treatment. *B*. Forty-eight hours after treatment, showing complete disappearance of cloudy calcareous deposit, though a small dense deposit remained unchanged. Eighteen months later this dense deposit was still unchanged but there was no recurrence of symptoms.

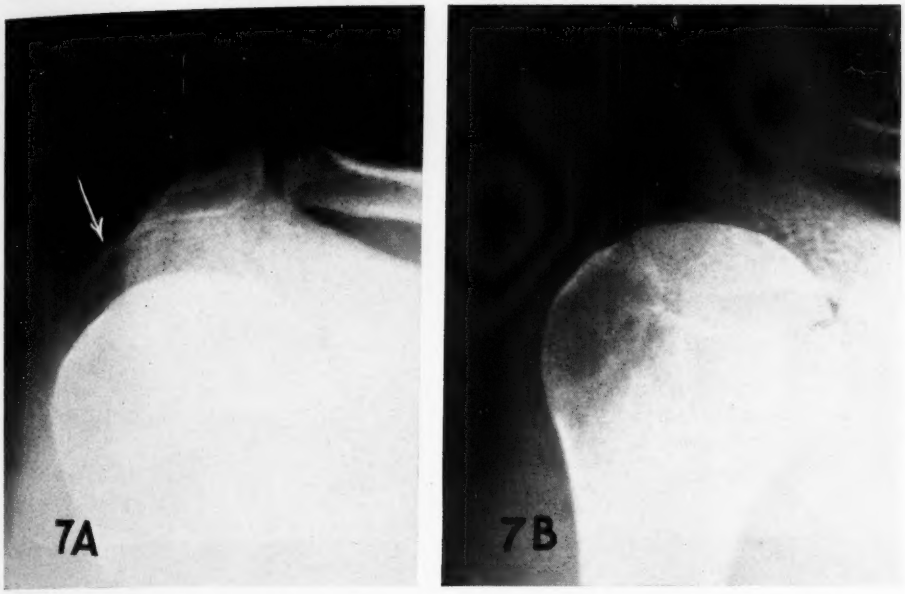

Fig. 7. Acute stage of calcified subacromial bursitis. *A*. Faint, cloudy appearing calcareous deposit before roentgen therapy. *B*. Complete disappearance of symptoms and the calcareous deposit 48 hours after one treatment.

in one patient (Fig. 5). Post-therapy roentgenograms revealed complete disappearance of the calcium deposits in all but one of these cases (Fig. 6). In 3 patients the deposit had disappeared within forty-eight hours (Fig. 7).

The remaining 3 patients in the subacute stage were sufficiently improved after one exposure to resume their normal routine, although some residual discomfort and calcareous deposit were still present when they returned four weeks later (Fig. 8). Complete relief of symptoms with disappearance of the calcareous deposit occurred within two weeks following the second treatment in these 3 patients. In one of these patients both shoulders were involved.

Two patients presenting the chronic stage of the disease were treated three times at four-week intervals with complete relief of symptoms and the disappearance of the calcareous deposits soon after the third treatment. The two remaining chronic cases did not respond to irradiation. Three treatments were given at four-week intervals without relief of symptoms or change in the calcareous deposit (Fig. 9).

Of the 18 patients with calcified subacromial bursitis treated by roentgen irradiation, 16 were completely cured, 11 with only one treatment. Although the time elapsed has been relatively short in a few of these cases, we have had no recurrence of the disease.

No definite relationship could be drawn between the roentgenologic appearance of the calcareous deposits and their response to roentgen irradiation. Generally speaking, however, the calcareous deposits that appeared hazy or cloudy responded best to treatment. In all of these patients the symptoms and deposits had completely disappeared within seventy-two hours after one exposure (Fig. 7). As a general rule, the larger and more dense the calcareous deposit appeared, the slower was the response to treatment. This did not seem to be true, however, in the presence of an extremely acute bursitis.

It is logical to assume that the action of roentgen irradiation in calcified subacro-

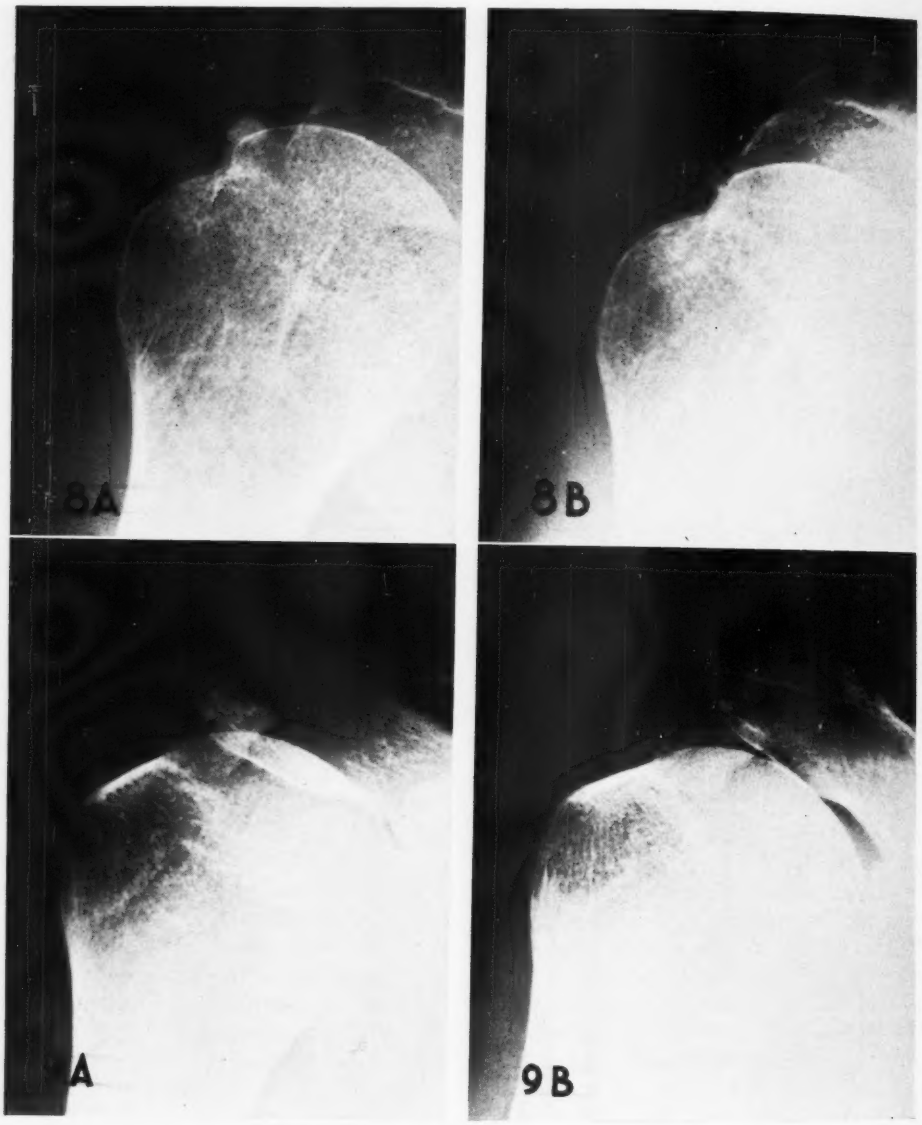

Fig. 8. Subacute stage of calcified subacromial bursitis. *A*. Before roentgen therapy. *B*. Four weeks following treatment; some residual discomfort and calcareous deposit still present. Symptoms and deposit completely disappeared two weeks following a second treatment.

Fig. 9. Chronic stage of calcified subacromial bursitis. *A*. Before roentgen therapy. *B*. Fourteen weeks later, no change in symptoms or the appearance of the calcareous deposit following three treatments at four-week intervals.

mial bursitis is similar to its action in other acute inflammations. Although no actual purulent material has been found in this disease, the histopathologic examinations reveal a definite inflammatory reaction, with cellular infiltration about the vessels. The rapid response of this condition to roentgen therapy is parallel to that of other acute infections. In the chronic stage the patient has very little pain and

tenderness. The chief symptom is limitation of motion, which is the result of fibrosis and adhesions. This stage has very little, if any, remaining active inflammation present; hence the poor response to roentgen irradiation.

SUMMARY AND CONCLUSIONS

Roentgen therapy in our experience is the treatment of choice in all acute and most subacute stages of calcified subacromial bursitis.

It is easy and economical to administer and a single exposure affords rapid and permanent relief of symptoms in the majority of patients.

The calcareous deposits present in this disease have no effect on the results of roentgen therapy. Our experience has shown equally good results whether or not these deposits were present.

Roentgen therapy should not be used in the chronic stage, where the outstanding symptom is restricted mobility. The changes in this stage are the result of fibrosis and adhesions, and irradiation will have no effect on them.

Scott-White Clinic, Temple, Texas

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DISCUSSION

Major Alfred A. de Lorimier M.D. (Washington, D. C.): I want to express my interest in Dr. Baird's paper. We have treated close to 100 cases at Gorgas Hospital in the Canal Zone, and are very enthusiastic as to the response shown by this type of case to roentgen irradiation. It has been our opinion that absorption of the calcific deposits occurs particularly when the treatment is given during the stage of acute activity, that is, when the patient complains of pain and when point tenderness can be elicited. It has been our experience to have patients brought in, actually crying with pain, and after the very first treatment to see a striking contrast in their facies. Complete alleviation of symptoms has been obtained after two or three treatments.

We have observed these calcific deposits in various tendons. They are not restricted to the shoulder region, and in the shoulder region they are apparently not confined to the bursa. We found them associated with the supraspinatus tendon, the infraspinatus, the teres major, the triceps, and I believe in one case with the short head of the biceps. I think it is quite necessary to distinguish the location of these calcific deposits because I believe it is important to use very small portals so placed that the radiation will be distributed to the proper portion of the tendon involved. We had several cases with deposits in the tendon of the gluteus medius and the piriformis in the hip, the tendons of the digits of the hands and feet, and those about the elbow and knee. Our localizations were made on the basis of stereoscopic and lateral projections. These cases also responded as Dr. Baird has described.

An interesting aspect of this disease is the possible influence of extremes of climate. Our cases were seen in the tropics, and we thought the incidence higher there than in the temperate zone. Shortly after our report, we heard Dr. Sandström's paper at the International Congress in Chicago, in which he described the treatment of some 300 or 400 cases in Norway.

We were of the opinion that these changes were found in patients with a lowered basal metabolism rate. When a white man goes to the tropics his blood pressure usually drops 15 to 20 points and in a high percentage of cases a decrease occurs in the basal metabolism. I am just wondering if there is not a relationship between this lowered metabolic rate and a relative vascular stasis which might account for stagnation of toxins, producing these reactions in the tendons.

I should like to say a word about the absorption of these deposits. I remember one case in which the calcific deposit was actually a stone in the long head of the biceps. In the roentgenogram it was seen to extend over an area measuring perhaps 2 inches in length and a quarter of an inch in diameter. The case was treated during the period of acute symptomatology and the pain was alleviated, but it was six months, as shown by monthly observations, before complete absorption occurred. Thus, even though complete absorption does not occur immediately (within a period of two weeks to a

month), it is still possible that it will occur over a period of months, and this incident to treatment.

Lester J. Freedman, M.D. (Pittsburgh): Dr. Baird is to be commended for his excellent paper. At the West Penn Hospital in Pittsburgh, we have a number of these cases and have had satisfactory results with low-voltage roentgen therapy. We have also encountered cases that did not respond to x-rays. We found that by giving diathermy first and following immediately with x-rays we increased the number of favorable results. The theory is that diathermy increases circulation, bringing leukocytes to the part. X-rays would destroy some leukocytes and the liberated antibodies would check infection.

John F. Chapman, M.D. (Pasadena): I have been interested in this subject for about two years and have had during that time about 50 patients. The results of treatment have certainly given great satisfaction to them, and to me.

One thing became evident to me very soon after I started treating this condition; that is, the great variation in results. These would be almost miraculous in some instances; in others there would be no effect, and yet a clinical distinction could not be made. Is it possible to explain the discrepancy? More discriminating diagnosis, and classification of patients might enable one to predict at the beginning of treatment what result is to be expected.

On looking up the literature, I immediately found Codman's book on "The Shoulder." There I was surprised to read that there is no, or very little, inflammatory reaction in these tissues. The patients upon whom he operated did not show round-cell infiltration about the calcareous deposits except in the cases where he believed there had been a recent rupture of the calcareous material into the overlying bursa. He believes that all these deposits start in the tendons themselves, and that they are not ordinarily evidences of an inflammatory process, but of a degenerative process. The tendons of the supraspinatus are found ruptured and degenerated but not inflamed.

Dr. W. A. Meyer, Professor of Anatomy at Stanford, years ago gave a series of papers on "Use-Destruction, or Attrition in Human Tissues," and proved that destruction of tendons in various parts of the body is a fairly common phenomenon. In one of his papers he reported 96 cases of destruction and dislocation of the long head of the biceps without evidence of an accompanying inflammatory reaction. He did not mention use-destruction of the supraspinatus tendon. These findings make it seem likely to me that we do not obtain results in shoulder cases by breaking down white blood cells as we do in inflammatory lesions, but in some other way, not theoretically understood as yet.

Robert R. Newell, M.D. (San Francisco): I am very enthusiastic about Dr. Baird's presentation. His experience has been unusually good. My recollection of such cases is not as good as Dr. Baird's but I am nevertheless enthusiastic about a moderate dose of x-ray for subdeltoid calcareous deposits. The deposit is usually in the expanded head of the supraspinatus, secondarily perhaps in the bursa, more rarely in other tendinous expansion. No one knows, of course, why the deposits are there, nor why there is so little microscopic evidence of inflammation. The patients present themselves in a state of great pain and with clinical signs of local inflammation.

I agree that the best results and the most dramatic reactions are obtained in patients in the acute stage. The calcium is cleared out, but whether it is the removal of the calcium that brings about relief I do not know. Both shoulders should be examined, for sometimes we see more calcium in the shoulder that doesn't hurt. I have known calcium to disappear in a number of patients that were seen in the acute stage and were given no x-ray treatment. It is possible, therefore, that part of the clearing out of the calcium is due to the patient's reaction and not to the irradiation.

Lester W. Baird, M.D. (closing): I agree entirely with Major de Lorimier that the calcareous deposits disappear more rapidly when the disease is acute. I think the results presented in my paper bear out that fact quite clearly.

It is true that these deposits may occur in tendons other than those about the shoulder joint. We have seen and treated this disease in the region of almost every joint in the body. This paper was limited to the deposits about the shoulder, as they are most commonly found in this area.

The basal metabolism rate was recorded in 32 of our 44 patients but was not mentioned because the information obtained did not warrant the drawing of any definite conclusions.

I do not think that we should take credit for the disappearance of the calcium deposits when this requires four to six months of interval treatments, as these deposits will at times disappear spontaneously.

I was interested in hearing about the use of diathermy in conjunction with roentgen therapy. I have used roentgen therapy in a few patients after diathermy had failed but have not used the combination. I shall try this method of treatment on some of the more stubborn cases in the future.

Dr. Newell implied that I am probably a little more enthusiastic than he is about the results obtained from this method of treatment. My report, of course, included only those patients that we were able to observe closely, roentgenographically, before and after treatment and does not include all of the patients treated. If the entire series had been used, the final results might have been altered somewhat. I think, however, the results will be much better if a careful selection of the cases is made before roentgen therapy is given.

Treatment of Peritendinitis Calcarea in the Shoulder Joint[1]

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THERE IS AN extensive literature dealing with the diagnosis, pathology, and treatment of peritendinitis calcarea, a condition which is often designated as "bursitis calcarea." The material available on its diagnosis and pathology is thorough and there is little to gain by further discussion of these aspects; a bibliography for general use on the subject is appended. In this paper we shall consider only the treatment, since this phase of the problem has various solutions.

The treatments in use for peritendinitis calcarea must be evaluated in view of their ability to relieve the condition speedily and also to bring about a cure. In considering statistics relative to the results of any form of therapy it must be kept in mind that both the symptoms and the calcification

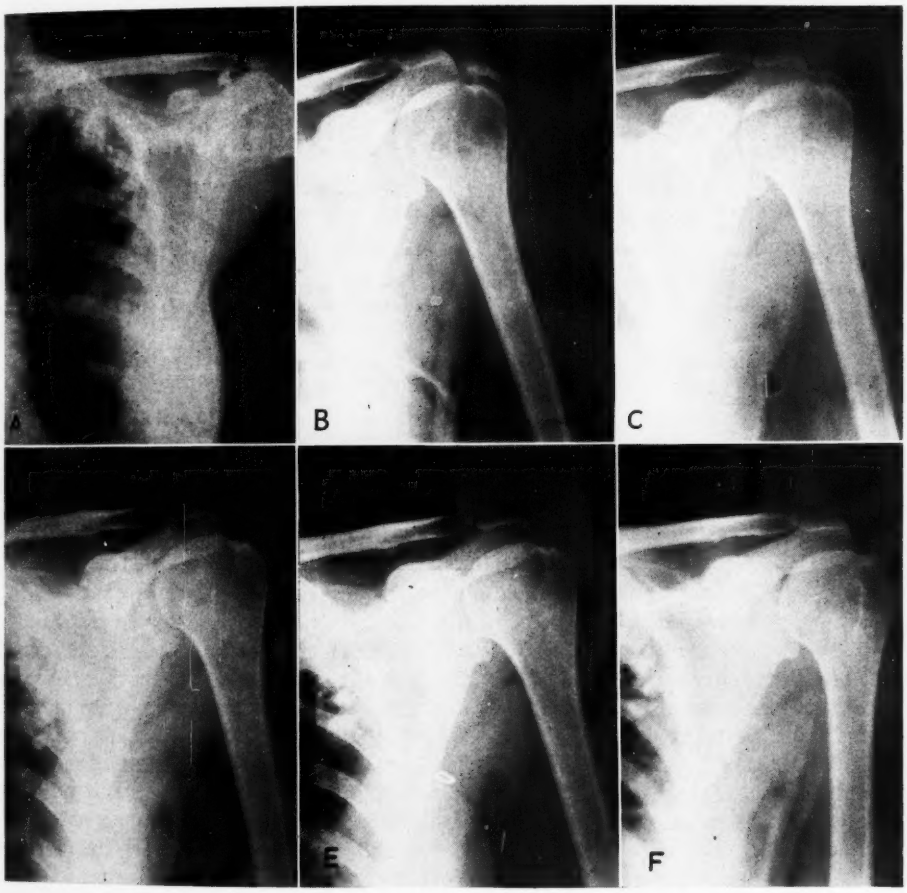

Fig. 1. Case 26: A. Calcification near the greater tuberosity, original chest film. B–F. Gradual resolution of calcification with roentgen therapy.

[1]Accepted for publication in December 1940.

TABLE I: FIFTY-TWO CASES OF PERITENDINITIS CALCAREA TREATED BY PHYSIOTHERAPY OR ROENTGEN THERAPY

Case	Age and Sex	History	Clinical Findings*	Calcification	Shoulder	Treatment	Days of Disability
1	38 M	While swinging case of milk, locked rt. shoulder	Localized tenderness	X	Rt	Phys.	28
2	39 M	Shoulder struck by blade of hand truck rebounding from floor	Localized tenderness	X	Rt	Phys.	45
3	42 M	Pulling railing around machine, wrenched rt. shoulder	Localized tenderness	X	Rt	Phys.	11
4	26 M	Slipped and fell, hurt rt. shoulder	Localized tenderness	X	Rt	Phys.	24
5	34 M	Fell and hurt rt. shoulder	Localized tenderness	X	Rt	Phys.	27
6	48 M	Thrown against wall, hurt rt. shoulder	Localized tenderness	X	Rt	Phys.	205
7	44 F	Sprained rt. shoulder while working at home	Localized tenderness	X	Rt	Phys.	25
8	32 M	Fainting attack, hurt rt. shoulder	Localized tenderness	X	Rt	Phys.	16
9	38 M	Rt. shoulder hurt when horse jerked wagon	Localized tenderness	X	Rt	Phys.	48
10	54 F	Sprained left shoulder pulling up dumbwaiter	Localized tenderness	X	Lt	Phys.	46
11	39 M	Lifting case of milk, pulled left arm	Localized tenderness	X	Lt	Phys.	63
12	48 M	Pain developed in left shoulder	Localized tenderness	X	Lt	Phys.	30
13	42 M	Wrenched rt. arm taking cases off trailer	Localized tenderness	X	Rt	Phys.	11
14	31 M	Fell against wagon when horse jerked it	Swelling, tenderness	X	Rt	Phys.	16
15	48 M	Loading truck, slipped on ice	Localized tenderness	X	Rt	Phys.	6
16	45 M	Pulling cases off wagon	Localized tenderness	0	Rt	Phys.	127
17	32 M	Reaching for handle on wagon, rt. shoulder locked	Swelling, tenderness	X	Rt	Phys.	83
18	35 M	Contusion of rt. shoulder	Localized tenderness	0	Rt	Phys.	148
19	48 M	Lost balance, struck left shoulder against wagon	Localized tenderness	X	Lt	Phys.	49
20	42 M	Slipped and struck left shoulder	Localized tenderness	X	Lt	Phys.	65
21	39 M	Slipped, playing golf, sprained rt. shoulder	Localized tenderness	X	Rt	X-ray	15
22	49 M	Thrown by horse	Localized tenderness	X	Rt	Phys.	25
23	45 M	No injury, gradual development of pain	Localized tenderness	X	Lt	Phys.	89
24	32 M	Suddenly developed pain in rt. shoulder	Localized tenderness	X	Rt	X-ray	8

itself may disappear spontaneously. In our series there was gradual absorption of the calcification without treatment in about 12 per cent of the cases. The majority of patients must be treated by one form of therapy or another.

The most radical of the methods of treating peritendinitis calcarea of the shoulder joint is surgery. These cases are managed by incision and curettement of the calcification in the tendon sheath. At times, needling is used. A more conservative procedure, in a large percentage of cases, is physiotherapy. This treatment may bring about relief of the symptoms but has the disadvantage of rarely effecting a disappearance of the calcification. Furthermore, patients treated by this method have a long period of disability, about fifty days, with or without reduction in calcification.

The method of treatment which we suggest as the most effective both for the relief of the symptomatology and the reduction of calcification is roentgen irradiation. With roentgen therapy the average disability period is reduced to about ten days. The acute symptoms are gone within a week. The accompanying table shows clearly the relative disability periods with physiotherapy and irradiation.

The cases tabulated come from several industrial organizations, and in all except a few latent cases the peritendinitis calcarea of the shoulder joint was caused directly by trauma or activity connected with routine work. These cases cover a period which includes 1932 and runs through September 1940. From 1932 to 1937 treatment was

TABLE I: FIFTY-TWO CASES OF PERITENDINITIS CALCAREA—*cont.*

Case	Age and Sex	History	Clinical Findings*	Calcification	Shoulder	Treatment	Days of Disability
25	50 M	Slipped on wet floor, injured left shoulder	Localized tenderness	X	Lt	X-ray	11
26	37 F	Gradually developing pain	Localized tenderness	X	Lt	X-ray	11
27	38 F	Gradually developing pain	Localized tenderness	X	Rt	X-ray	7
28	43 M	Thrown to sidewalk	Localized tenderness	X	Lt	Phys.	23
29	42 M	Backing up, fell back on wagon	Localized tenderness	X	Lt	Phys.	30
30	35 F	Severe pain left shoulder	Localized tenderness	X	Lt	X-ray	7
31	34 M	Suddenly developing pain	Localized tenderness	X	Rt	X-ray	21
32	51 M	Gradual pain	Localized tenderness	0	Rt	X-ray	11
33	32 M	Slipped and fell against door	Localized tenderness	X	Lt	Phys.	12
34	58 M	Fell off tender, bumped rt. shoulder	Localized tenderness	0	Rt	X-ray	8
35	44 F	Wrenched rt. shoulder opening ventilator	Localized tenderness	X	Rt	X-ray	16
36	62 M	Sprained rt. shoulder	Localized tenderness	X	Rt	X-ray	8
37	36 M	Slowly developing pain	Localized tenderness	X	Rt	X-ray	8
38	49 M	Pain developed over night	Swelling, tenderness	0	Lt	X-ray	7
39	31 F	Pain in rt. shoulder for two years	Localized tenderness	X	Rt	X-ray	8
40	51 M	Gradually developing pain	Localized tenderness	X	Rt	X-ray	4
41	37 M	Pain in shoulder after tennis match	Localized tenderness	X	Lt	X-ray	3
42	64 M	Injury to left shoulder, after fall	Localized tenderness	X	Lt	Phys. + X-ray	7
43	36 M	Contusion to rt. shoulder	Localized tenderness	X	Rt	X-ray	13
44	35 F	Gradual pain rt. shoulder for three weeks	Swelling, tenderness	X	Rt	X-ray	10
45	40 M	Fell, injuring rt. shoulder	Localized tenderness	X	Rt	X-ray	11
46	45 F	Injury to left arm	Localized tenderness	X	Lt	X-ray	7
47	39 M	Gradual pain left shoulder	Localized tenderness	X	Lt	X-ray	15
48	36 F	Pain in rt. shoulder	Localized tenderness	X	Rt	X-ray	14
49	40 M	Pain in rt. shoulder after swimming	Localized tenderness	X	Rt	X-ray	10
50	54 F	Pain in left shoulder, 2 months' duration	Localized tenderness	X	Lt	Phys. + X-ray	14
51	61 M	Bumped rt. shoulder 5 months previously		X	Rt	Phys. + X-ray	17
52	35 M	Pain in rt. shoulder for 2 weeks		X	Rt	X-ray	6
						Average disability with physiotherapy	50 days
						Average disability with roentgen therapy	10 days

* Limitation of motion in all.

by physiotherapy only; from 1937 to 1940 by roentgen therapy.

Physiotherapy took the form of infra-red therapy and diathermy. Roentgen therapy was given as follows: 75 to 100 r in air every three to seven days for four doses. The second course, when given, followed after a month's rest period and was the same as the first. The fields were varied. The factors were 125 kv., 4.0 mm. Al, 5 ma., 30 cm. distance, field 8 × 8 cm., or 180 kv. 4 ma., 40 cm. distance, 0.5 mm. Cu and 1.0 mm. Al, field 10 × 10 cm. The response was the same from both methods. The method was determined by the thickness of the shoulder.

The results achieved by roentgen therapy in reducing the disability period and effecting the disappearance of the calcification appear in the table but may be further illustrated by a few case histories.

CASE 26: Mrs. G. was first seen in 1936, when a chest film showed, incidentally, a large calcification near the greater tubercle of the left shoulder. She returned in August 1938 with symptoms of pain and tenderness in the shoulder, for which she had had physiotherapy (not by us) for a period of two months. She derived little relief from the treatment. We gave her a course of roentgen therapy. Seven days later there was a complete relief of the acute symptoms. Two courses of roentgen therapy followed the original course at intervals. There was a gradual absorption of the calcification after the treatment, as the final roentgenogram, August 16, 1940, shows.

CASE 35: Mrs. L. wrenched her right shoulder and suffered acute pain and tenderness at the site. She had received a course of physiotherapy with no relief.

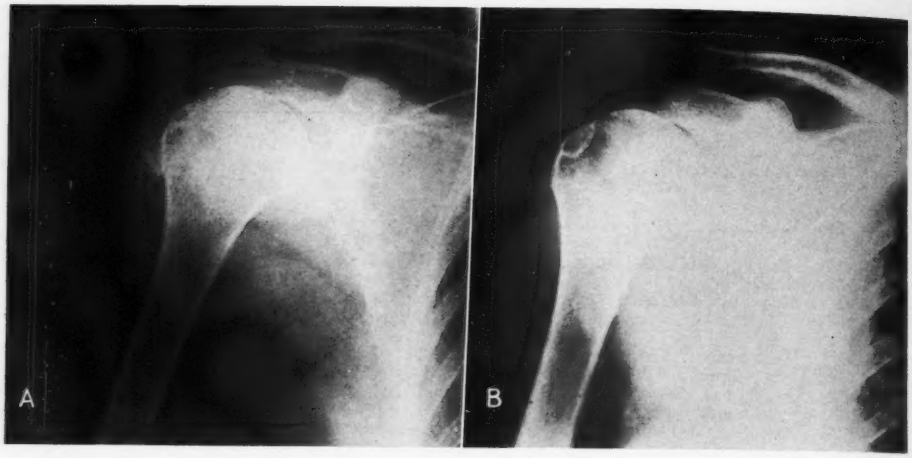

Fig. 2. Case 35: A. Calcification near the greater tuberosity. B. Complete resolution ten weeks after roentgen therapy.

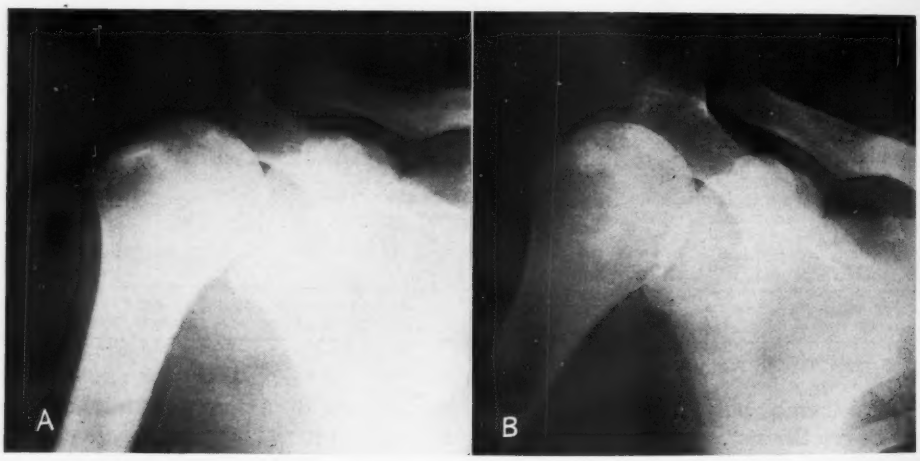

Fig. 3. Case 37: A. Calcification near the greater tuberosity. B. Roentgenogram taken ten weeks after roentgen therapy, showing a residual trace.

She came to our office May 31, 1939, and after a course of roentgen therapy was discharged, totally relieved, June 15, 1939. A roentgenogram taken August 5, 1940, shows complete resolution of the calcification.

CASE 37: Mr. L. came to our office July 6, 1939, with pain, localized tenderness, and limitation of motion in his right shoulder, developing over a period of time. A roentgenogram taken on that date showed a large calcification in the region of the greater tubercle of the shoulder. Roentgen therapy was begun immediately, and the patient was discharged July 19, 1939, clinically cured. A follow-up film, August 25, 1939, shows a trace of residual calcification.

CASE 47: Mr. L. came to our office Dec. 12, 1939, complaining of pain in the left shoulder. A roentgenogram taken at the time showed a large calcification near the greater tubercle of the left humerus. A course of roentgen therapy was given and the patient was discharged, clinically cured, Dec. 27. A film taken Aug. 5, 1940, shows a trace of calcification.

CASE 48: Mrs. M. came to our office Feb. 13, 1940, with pain, localized tenderness, and limitation of motion in her right shoulder. She was given a course of roentgen therapy and was relieved of symptoms within two days. A roentgenogram taken on April 16, 1940, shows a small residue of calcification.

CASE 50: Mrs. R. had received, elsewhere, a two months' course of physiotherapy for pain in the left

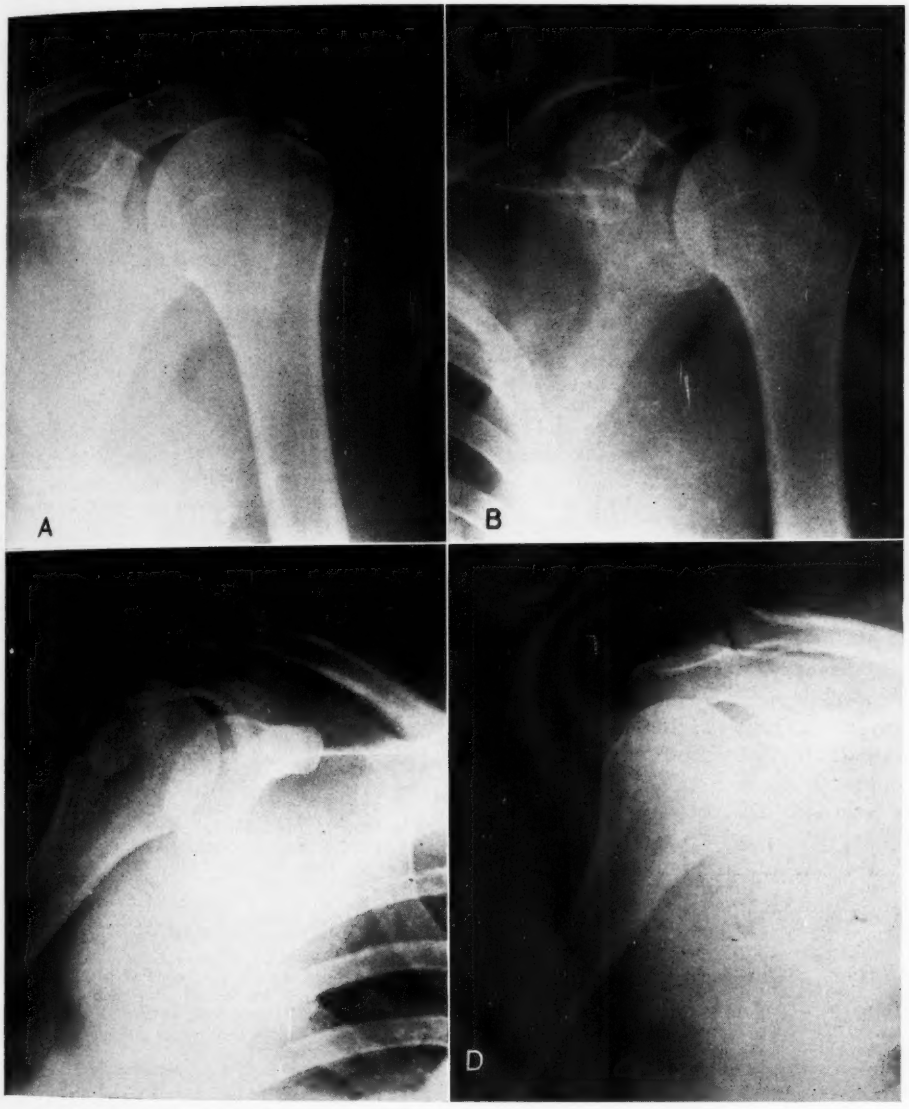

Fig. 4. Cases 47 (A and B) and 48 (C and D): Calcification near the greater tuberosity, with roentgenograms nine months after roentgen therapy in Case 47 (B) and two months after roentgen therapy in Case 48 (D), showing only a trace remaining.

shoulder, without relief. On Feb. 26, 1940, she came to our office and a course of roentgen therapy was at once begun. The symptoms disappeared in six days. A roentgenogram taken Aug. 3, 1940, showed only a small residue of the calcification.

CASE 52: Mr. L. came to our office Sept. 6, 1940, complaining of acute pain, tenderness, and marked limitation of motion in the right shoulder. The onset of symptoms dated back two weeks, with acute pain for two days. A roentgenogram shows a large calcification in the region of the greater tubercle. Roentgen therapy was administered and six days later there was a complete relief of symptoms. It is interesting to mention here that six months previously, this patient had a similar condition in his left shoulder. At that time he was treated elsewhere by physiotherapy for twelve weeks before he was able to resume work and he still had some pain and limita-

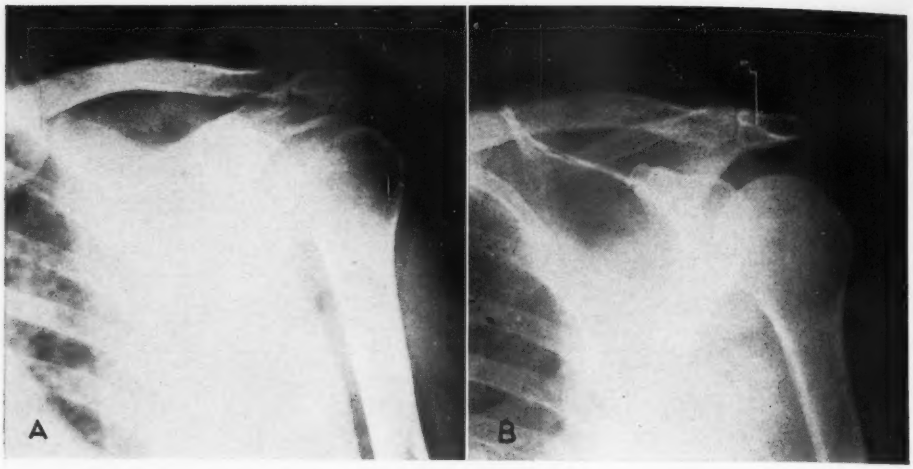

Fig. 5. Case 50: A. Calcification near the greater tuberosity. B. Roentgenogram taken six months after roentgen therapy, showing only a residual trace.

tion of motion in that shoulder. This case illustrates most strikingly the efficiency of roentgen therapy for this condition.

CONCLUSIONS

It would appear from our experience that roentgen therapy is the optimal method of treating peritendinitis calcarea of the shoulder joint since it reduces considerably the period of disability and tends to bring about resolution of the calcification. It has also the advantage of conservatism.

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Milliammeters at Ground Potential in X-ray Tube Circuits[1]

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THE ADVANTAGE of having the milliammeter at ground potential is usually incorporated in modern x-ray equipment. The trend has been entirely justified by the progress made in high-voltage insulation and has been realized, in certain instances, by constructional changes in otherwise sound circuits. It has been possible, however, to attain the main purpose in connection with two old x-ray machines without incurring expensive modifications. Since the solutions may be of some interest to the radiologist and the manufacturer of x-ray equipment, they will be described in some detail.

The first problem arose in connection with an installation of the type schematically shown in Figure 1-A. A high-voltage transformer of large current capacity feeds two water-cooled x-ray tubes connected in parallel but in such a way that each utilizes alternate halves of one cycle.[2] The anodes are cooled by city tap water which is let in and out of the x-ray tubes through suitably designed glass coils The average current loss through each coil is about 1.3 milliamperes at 200 kv. c.p.

The simple solution offered by Du Mond (1) in his stereofluoroscope was not deemed satisfactory, since in x-ray therapy adjustment of the milliammeter is a more frequent and more exact operation than in fluoroscopy. Furthermore, the response of the technician to direct readings is apt to be more prompt than the response implied by deductive reasoning.

An alternate solution, almost as simple, is offered in Figure 1-B. The high-voltage winding was opened at its center tap. Two inexpensive mercury vapor rectifiers (type 866jr) were inserted in opposition, as shown in the figure; under these conditions each meter reads the current flowing through one-half of the cycle. The 866jr is rated at 1 ampere; the potential drop across it during the use-

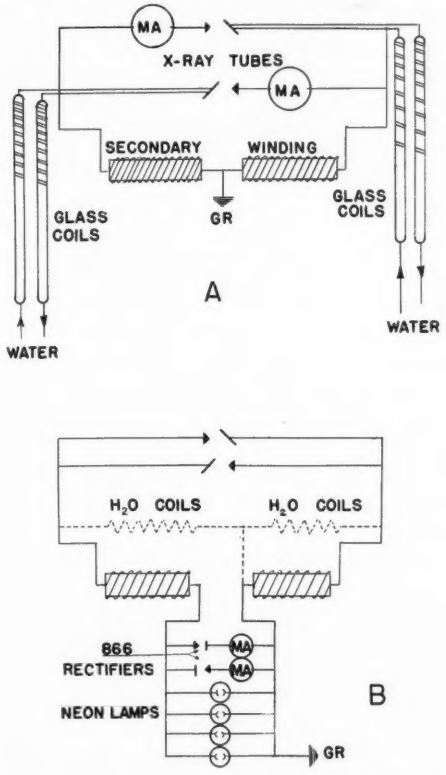

Fig. 1. A. Diagram showing connection of milliammeters at high potential in circuit consisting of a H.V. transformer feeding two x-ray tubes without special circuit for rectification. B. Same circuit with milliammeters connected at ground potential.

[1] Acknowledgment is made to the Works Projects Administration of New York City for assistance rendered under Project No. 24. Paper accepted for publication in October 1940.

[2] This circuit was introduced by Dr. Failla in 1933 in order to eliminate in a simple and economic way the disadvantages of the mechanical rectifier in one of the 200-kv. machines in the X-ray Department of Memorial Hospital, and at the same time increase the treatment facilities. Since then other installations of this type have been made at the Memorial Hospital and elsewhere. It is rather surprising to find that the average x-ray tube life under these conditions is considerably longer than in the case of circuits with rectifying means or constant potential.

ful cycle is only 15 volts. Direct comparison of milliammeters suitably connected failed to show any difference in reading. The meters will register the current flowing through the cooling system to ground; to be exact each will register the *total* leakage current during one-half of the cycle. Since this current can be measured independently by disconnecting the x-ray tubes, it can be easily accounted for.

Some precautions are, however, necessary to avoid possible high potential at the control board if the continuity of the circuit is broken. This may be caused by burning of the milliammeter coil or by failure of the rectifier tube in conjunction with accidental grounding of a H.V. lead. Good protection is afforded by a bank of several 3-watt neon lamps connected in parallel with the measuring system, as shown. Since their ignition potential is about 60 volts, they will not by-pass any current when the rectifiers are operating. They will, nevertheless, take all the current of the circuit (if both rectifiers or meters fail) without developing more than 110 volts at their terminals. As an ultimate safety device a very small point gap is added. Two of these installations have been in operation for over a year without requiring any attention.

The second machine requiring modification was an early constant-potential 200-kv. Wappler (2) generator of 10 ma. capacity installed in our standardization laboratory. It is characterized mainly by its centra[1] unit, consisting of a Greinacher (3) constant-potential doubling circuit (Fig. 2-A) supplying 100 kv. and two additional c.p. units to boost the voltage at the tube to 200 kv. The x-ray tube current is customarily measured by a suitable milliammeter in series with the condenser at 50 kv. from ground.

The correct wiring for a grounded meter in such circumstances is far from obvious. The x-ray tube current flows through three different circuits during each cycle, that is (Fig. 2-A) (*a*) through 1-3-6-7-12-14-15-18-19-1 during the simultaneous discharge of all condensers; (*b*) through circuit 1-3-6-7-12-9-10-14-15-16-17-18-19-1 during the time in which the condensers on the right of the figure are being charged; (*c*) through circuit 1-3-4-5-6-7-8-9-12-14-15-18-19-1 when the condensers on the left side of the figure are being charged.

It can be shown[3] that the charging fraction of a cycle is not negligible and therefore the milliammeter must be connected in series with the x-ray tube throughout the cycle. After some experimentation with a model set up operating at 2,000 volts, the circuit shown in Figure 2-B was developed. It is obtained by breaking the common ground connection (marked 12 in Figure 2-A) and by inserting a triangular circuit 13-11-12, consisting of a milliammeter across 11 and 13 and two 866 mercury vapor rectifiers along the remaining sides of the triangle, properly connected so as to shunt the condensers' charging currents and yet keep the milliammeter in series with the tube in any of the three circuits mentioned before.

The grounding of this circuit could be made at any of the vertices. Vertex 13 was at first chosen when working with the model because it permitted direct grounding of the meter and, at the same time, a conve-

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[3] The charging period of the condenser in the fundamental circuit 12-14-10-9 cannot be calculated readily (4; 5) by rigorous analysis; it can, however, be estimated with satisfactory accuracy in explicit form if one neglects the potential drop across the valve tube and the resistance of the secondary winding. Let E be the peak E.M.F. of the secondary winding, C the capacity of the condenser, I the x-ray tube current, and ω the angular frequency of the power source. If one takes as the origin of the time co-ordinate (Fig. 2-C) the crest of the wave, then the charge acquired by the condenser in time t must equal the loss of charge through the x-ray tube in time $T - t$, where $T = 2\pi/\omega$ is the period of the wave, namely:

$$CE(1 - \cos \omega t) = \left(\frac{2\pi}{\omega} - t\right)I \qquad (1)$$

For values of $\omega t < 35°$, $\cos \omega t = 1 - \frac{(\omega t)^2}{2}$ to better than 1 per cent. Substituting in (1) and solving the quadratic we get to a good degree of approximation

$$\omega t = \sqrt{B^2 + 4\pi B} - B$$

provided $B = \frac{I}{\omega CE} < .03$. In our case: $I = 1 \times 10^{-3}$ amperes. $E_m = 5 \times 10^4$ volts. $C \simeq 2 \times 10^{-8}$ farads and $\omega = 377$ radians; that is, $B = 0.0265$; therefore $\omega t = 0.552$ or $t = 17.5\%$ of one-half a cycle.

nient way of shunting the leakage current flowing through the water coils. In fact by means of a imple self-shorting switch one could read the leakage current by transferring the ground connection to 11. The application of this circuit to the high-voltage generator necessitated, however, minor but essential modifications. It soon became apparent that, at variance with the model circuit, the intrinsic capacity of the secondary windings to the grounded cores was not negligible compared to the capacities in the constant-potential circuit, and that spurious currents were flowing through the grounded meter.

As an example, the distributed capacity between the central secondary winding and ground can be represented by an equivalent condenser between 9 and the grounded point; let this be 13. This capacity would charge *via* 9-12-13-9 but would discharge *via* 9-13-11-12-9 The net result is a pulsating current which does not flow through the x-ray tube but it is registered by the grounded meter. Similar results would follow if 11 were grounded.

Grounding of point 12, instead, eliminates these spurious currents almost completely and keeps the milliammeter at a voltage not over 15 volts from ground. A small but reproducible discrepancy remains between the true tube current and the current registered by the grounded meter. It is of the order of 0.1 ma. at very low kilovoltage, but it cannot be detected at 200 kv. Preliminary studies with an oscillograph reveal that this difference is of a rather complicated nature. It is proposed to investigate this point further in the near future.

If one is to retain the advantages of using tap water for cooling the x-ray tube and to retain also the convenience of reading or not reading the leakage current through the water coils, the following precautions are necessary. The glass coils are connected to short sections of copper tubing. These are electrically connected to point 11 or point 13 according to whether the leakage current is to be read or not. Since the incoming and outgoing water must ultimately reach ground potential, it will carry some current between points 13 and 12, which should be read by the milliammeter. This current, however, can be rendered negligible by attaching to the copper tubes suitable lengths of rubber tubing, which are

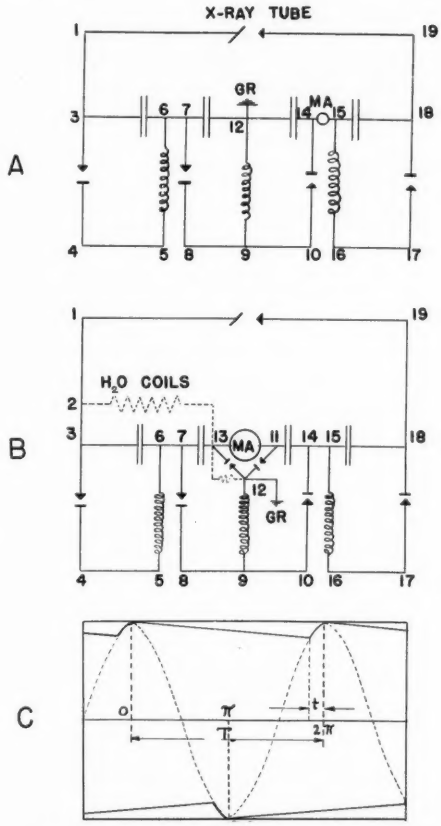

Fig. 2. A. Wappler constant-potential x-ray machine. B. Same machine with milliammeter at nearly ground potential. C. Typical potential wave form of constant-potential x-ray machine.

in turn connected, respectively, to faucet and sink.

The safety device discussed before can be conveniently applied in this circuit by connecting three banks of neon lamps in parallel with the sides of the triangle. It is hoped that grounding circuits of this sort may, on many occasions, facilitate the modernization of existing roentgenologic apparatus by providing a means of simplification in shock-proofing and of elimina-

tion, in some cases, of extra observation windows.

NOTE: The writer wishes to thank Mr. P. E. Stogoff for assistance in some experiments performed in the course of the work.

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Note on the Distribution of Surface Radiation from a Million-Volt Generator

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THE MILLION-VOLT x-ray generator of the type installed at the State Institute for the Study of Malignant Disease at Buffalo, in June 1940, has been described by Charlton and others (1). Because this equipment is more or less custom-built, the details of the target and number of portals were left to the choice of the purchaser. After due consideration it was decided to provide the equipment with two portals of radiation so that the two beams could be used either independently or simultaneously, as desired. One port provides for a beam of radiation transmitted through a tungsten target in the forward direction of the electron beam, while the other port provides for a beam of radiation reflected from the surface of the same target at right angles to the direction of the electron beam (Fig. 1). This arrangement was chosen since it provided one beam which was "hardened" by filtration in the target itself and one which could be filtered to produce any degree of hardness ranging in effective wavelength from 38 X. U. to 27 X. U., the hardness of the transmitted beam.

In the calibration of this equipment certain difficulties were to be expected. The fact that the target is placed at a 45° angle with respect to the long axis of the tube results in a differential filtration of the radiation of the transmitted beam, as a result of which the intensity might be expected to be asymmetrical. Furthermore, it was determined by means of pinhole photographs that the focal spot was not in the geometric center of the target, but at the lower edge, and although a focusing coil has been provided, it was not practicable to alter the position of the focal spot. As was pointed out by Leucutia and Corrigan (2) and Corrigan and Cassen (3), this off-center focal spot could still further affect the symmetry of the beam of x-rays. Our first consideration, therefore, was to determine the spatial distribution of both beams. Intensity measurements were made at 70 cm. distance in air by means of a thimble ionization chamber over the angle of radiation

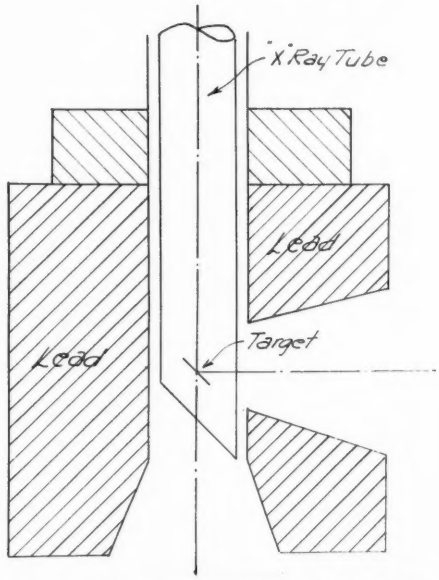

Fig. 1. Diagrammatic sketch of the million-volt generator, showing the target and both the transmitted and reflected beams.

determined by the geometry of the apparatus, for both the transmitted and the reflected beams, as shown in Figure 2. Surface measurements on a prestwood phantom were also made at a target distance of 70 cm. covering the entire field. Both sets of measurements confirmed the fact that the radiation was too asymmetrical or too distorted to be utilized without further modification. Figure 3 is the surface isodose curve for the vertical beam, showing its asymmetry.

[1] From the State Institute for the Study of Malignant Diseases, Buffalo, New York, Burton T. Simpson, M.D., Director. Accepted for publication in March 1941.

Since it was impracticable, because of construction, to alter the focal spot, as recommended by Leucutia and Corrigan, it was decided to endeavor to rectify the asymmetry by the introduction of graded filters. A wedge of lead was fixed in the transmitted beam with the thick portion in the region of greatest intensity. The dimensions of the wedge, or the thicknesses of lead required to make the beam symmetrical, were calculated by using the absorption coefficient for the quality of radiation in the beam with the intensities indicated in Figure 2. A similar correcting wedge of copper, chosen because it was desirable not to harden the beam unduly, was fixed in the horizontal beam.

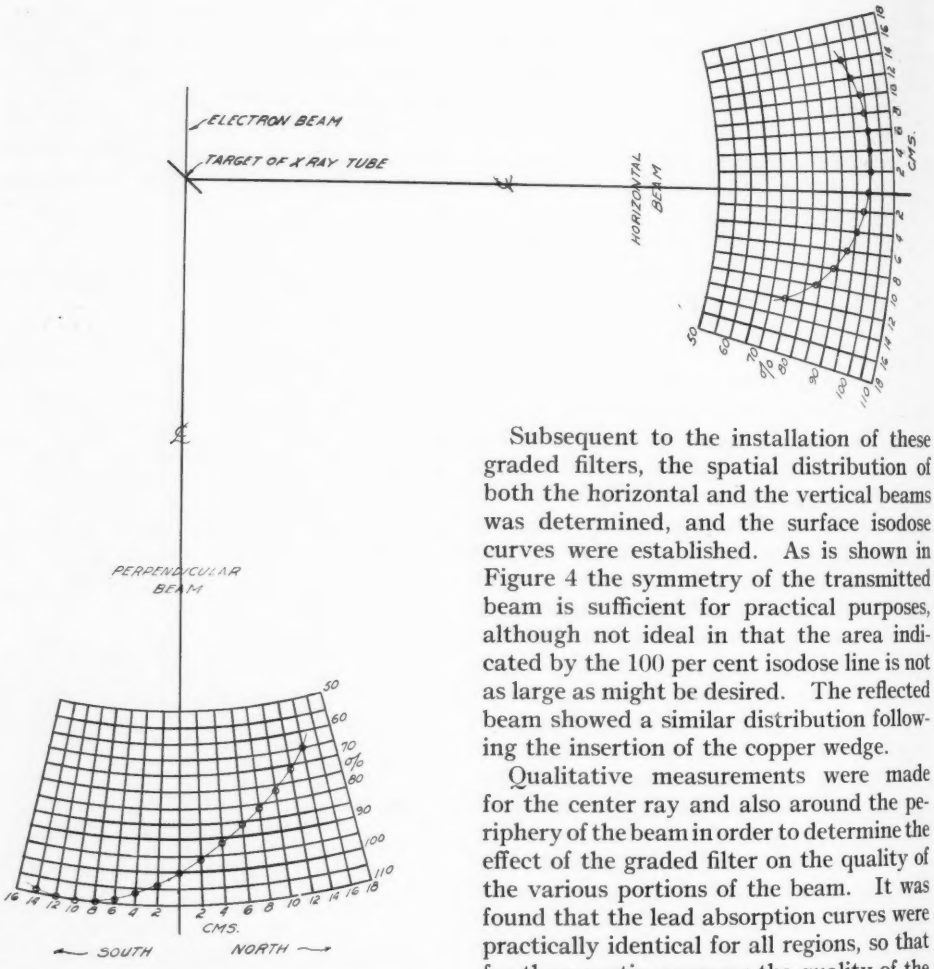

Fig. 2. Spatial distribution of intensity in air over an arc at 70 cm. distance for both the horizontal and vertical beams.

Subsequent to the installation of these graded filters, the spatial distribution of both the horizontal and the vertical beams was determined, and the surface isodose curves were established. As is shown in Figure 4 the symmetry of the transmitted beam is sufficient for practical purposes, although not ideal in that the area indicated by the 100 per cent isodose line is not as large as might be desired. The reflected beam showed a similar distribution following the insertion of the copper wedge.

Qualitative measurements were made for the center ray and also around the periphery of the beam in order to determine the effect of the graded filter on the quality of the various portions of the beam. It was found that the lead absorption curves were practically identical for all regions, so that for therapeutic purposes the quality of the radiation is uniform over the usable treatment areas.

	H.V.L. mm. Pb
Graded filter	1.45
1 mm. Pb 1 brass	2.23
2 mm. Pb 1 brass	2.97
3 mm. Pb 2 brass	3.3
5 mm. Pb 3 brass	4.12

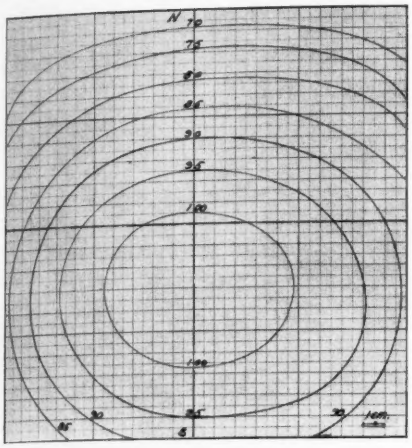

Fig. 3. Surface isodose curve for the vertical beam, showing its asymmetry.

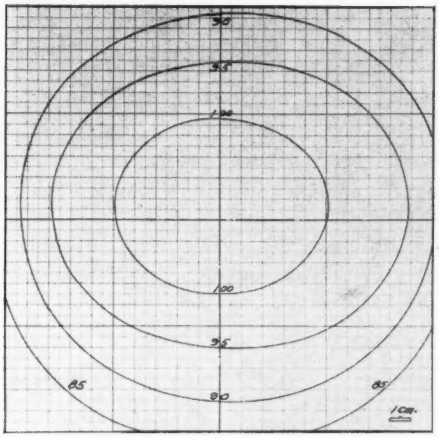

Fig. 4. Surface isodose curve for the vertical beam after insertion of the lead wedge

The accompanying table gives the quality of the beam in terms of half value layer of lead for the filtration as indicated.

CONCLUSION

The asymmetry of a million-volt beam of x-rays can be satisfactorily corrected by the introduction of wedge-shaped filters. These are simple and easily made and can readily be altered should the need arise.

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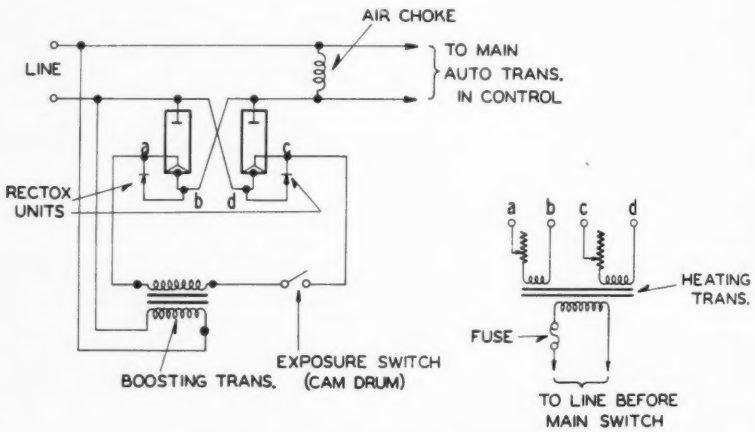
Some Recent Contributions of Physics and Engineering Research to Radiology[1]

BENEDICT CASSEN, PH.D.

THE FOLLOWING selected topics are illustrative of the recent contributions made by physics and engineering research to the science of Radiology. They are by no means intended to represent with any degree of completeness the constant procession of advance and improvement of radiological equipment. Also, other, competitive ways of accomplishing similar results can frequently be employed. Unfortunately, perhaps, the topics selected bear more upon radiography than therapy.

Before discussing these topics, I should like to include a few words to help increase the appreciation by radiologists of the attainments of development engineers. Many projected advances look quite simple and straightforward when first assigned to an engineer to be made into an accomplished fact. In the vast majority of cases, however, unforeseen difficulties arise which, even though they may seem of a trivial nature, must be overcome in order to get results. Translating laboratory accomplishment into apparatus of high reliability for use by the non-engineer has almost always this troublesome characteristic.



SCHEMATIC OF IGNITRON TIMER

Fig. 1.

IGNITRON TIMING

To begin with I shall describe the development of ignitron timing in high-speed, high-power radiography. In many modern radiographic installations using rotating anode tubes the power-supply line and voltage-generating equipment must handle as much as 75 kilowatts for a small fraction of a second. This power, if not accurately timed and controlled, can do much damage. At 250 volts it represents a current of 300 amperes. Theoretically, a synchronous mechanical timer designed to open and close the circuit when the alternating current through it is at its zero value would be suitable. Due, however, to power factor changes in the load with voltage and milliamperage variations, the time of zero current varies relatively to

[1] Read before the Radiological Society of North America, at the Twenty-sixth Annual Meeting, Cleveland, Ohio, May 2–6, 1940.

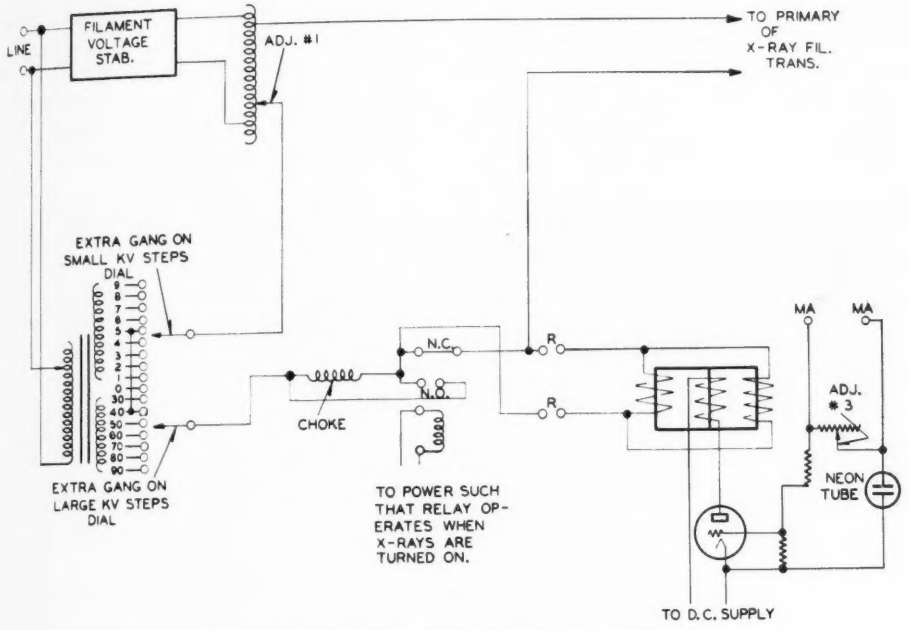


Fig. 2. A circuit used for automatic exposure control.

the voltage. This introduces more or less arcing at the contacts, with all its attendant troubles. A similar problem exists in electric spot welding where, also, an accurately controlled high power is necessary for a very short time. This latter problem has been neatly solved by the use of ignitron tubes. It would seem at first that the same method could be used directly in x-ray timing, but it soon became apparent that much more engineering development was necessary. Figure 1 shows diagrammatically a circuit that has been found satisfactory.

An ignitron tube is a vacuum tube device in which a relatively small power source starts an arc from a boron carbide electrode, called an ignitor, to a pool of mercury. The cathode spot of this arc acts then as that of an arc from the pool of mercury to a third electrode, the power anode. The power arc automatically extinguishes at the end of the current half cycle and will not re-establish unless reignited. Therefore, a synchronous timer operating on the ignitor circuit with small power can control the high currents through the ignitron tubes. One might think of the ignitron as a power amplifier. In order to take care of power factor variations the current through the ignitrons is made to lag the voltage definitely by means of an air choke. The ignitor voltage is chosen so that ignition takes place immediately after zero current on each half cycle. On the first half cycle no current flows until the first ignition; while on the later half cycles, current is still flowing from zero voltage to the ignition point due to the phase difference. If a test is made with a spinning top, this effect shows up in the failure of the first spot to be of full

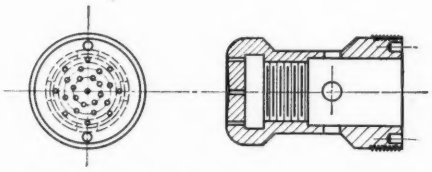


Fig. 3. New oil spreader for therapy tubes.

intensity, but the intensity lost is exactly made up by the last spot, which likewise fails to attain the full intensity of the intermediate spots. Once this action is understood, there will be no difficulty in interpretation of the spinning top test.

the choke coil shown in the circuit. During the exposure a saturable iron reactor takes the place of the choke coil. The reactance of this reactor can be varied by changing the D.C. through the center coil. This current is controlled by the actual

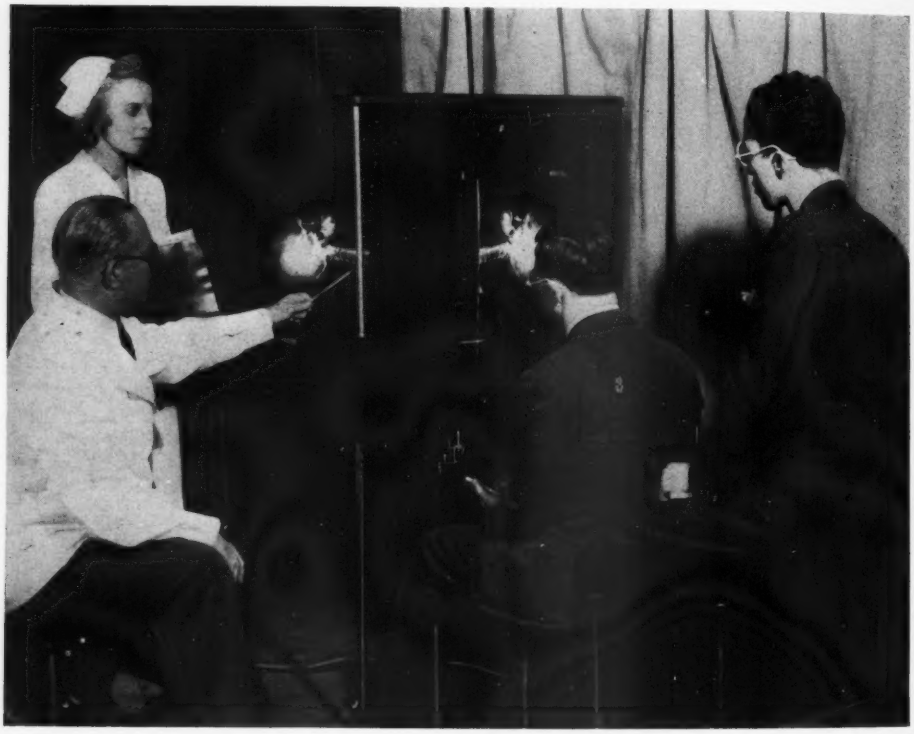


Fig. 4. Polaroid steroscope.

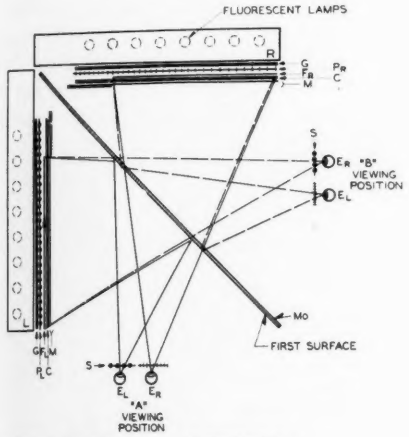
AUTOMATIC EXPOSURE CONTROL

The use of accurate high-power timers, such as the ignitron timer, is only one factor in designing equipment to enable the radiologist to obtain automatic control of uniformity and reproducibility of high-speed, high-power radiographs. Various methods have been devised for obtaining accurately controlled filament settings to give definite predetermined milliamperages at various voltage settings. The schematic circuit reproduced in Figure 2 shows one way in which this goal has been attained. Preadjustments are made for each milliamperage and kilovoltage with milliamperage through the x-ray tube so that any small variations in conditions that are not taken care of by the presetting are automatically cancelled by variations in the reactance of the saturable iron reactor. Uniform results are thus obtained.

OIL COOLING FOR THERAPY TUBES

A recent improvement of more interest in therapy than some of the others described here is an improved oil-cooling arrangement for 200-kv. therapy tubes. In the original design a spreader forced a thin film of oil under high speed in back of the target. A careful study of full

load temperatures by means of a thermocouple inserted in an anode at a point on the back surface showed a typical result of a temperature of 218° C. with 4 gal. of oil per minute under full load conditions. The heating at the anode was supplied in these tests by passing a heavy current through a carbon button pressed against



SCHEMATIC PLAN OF POLAROID STEREOSCOPE

Fig. 5.

the anode face. This temperature of 218° C. was not too high for most operating conditions, but there was not much margin of safety to take care of temporary unusual circumstances. It was suggested that if the flow in the thin film was made more turbulent the cooling efficiency would be improved. A spreader, illustrated in Figure 3, was made with small holes as shown. Comparative measurements showed that the temperature of the back of the target could be reduced as much as 100° C. for the same oil flow under load conditions. This gives a very adequate margin of safety to prevent cracking of the oil and suggests, if any desirable purpose could be served by doing so, that tube power ratings might be increased.

POLAROID STEREOSCOPE

An interesting development is the polaroid stereoscope. A detailed description of this device, by Mr. Roger Stamm, has appeared in a recent issue of the *American Journal of Roentgenology*. It enables many viewers simultaneously to obtain stereoscopic vision of x-ray films without any critical positioning of the viewers' heads. This greatly increases the comfort of stereoscopic viewing and enables a group to follow a description or discussion of the films. The observers must wear polaroid glasses. Figure 4 shows the stereoscope being viewed by a group. Figure 5 shows schematically the construction. The partially silvered mirror enables both pictures to be seen superimposed at the viewing position. Each image is polarized in a suitable direction by polaroid screens over the films. The polaroid glasses of the observer enable each eye to see only its proper image.

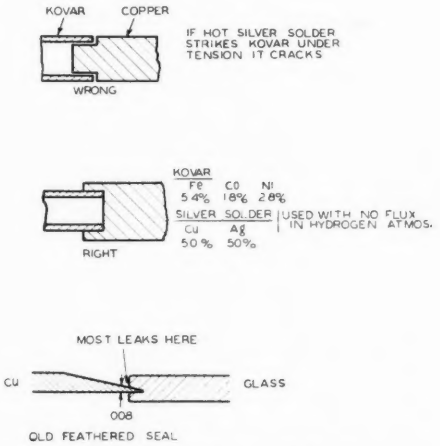


Fig. 6. Methods of using Kovar.

KOVAR-GLASS SEALS

Most of us are not aware that a great improvement in x-ray tube construction has recently been put into full effect. This improvement consists in abandoning the old feathered copper-glass seal for Kovar-glass seals. Kovar is an alloy con-

sisting of 54 per cent iron, 18 per cent cobalt, and 28 per cent nickel. Its thermal expansion is such that it can be sealed directly, even in very large diameter joints, to a glass known as 704, softening at 697° C. Most tubes are made of pyrex 774 of softening point 819° C. In order to take full advantage of the Kovar sealing properties, a double graded glass seal is made, the Kovar is sealed to the 704, which is sealed to 707 glass of softening point 746° C., which is then sealed to the 774 pyrex. Some rectifier tubes have a glass envelope of 704 which is directly sealable to the Kovar, but must be graded at the cathode end by means of 775 pyrex in order that tungsten filament leads may be used. In this development, the engineers again found unexpected difficulties. For example, in silver soldering the copper anode to the Kovar sleeve the first arrangement shown in Figure 6 was used. It was soon found that, when hot silver solder strikes Kovar under tension, it cracks. The tension due to the greater expansion of the copper when hot is large in this arrangement. The difficulties were overcome by putting the copper on the outside of the Kovar sleeve. The third diagram in Fig. 6 shows schematically the old feathered seal.

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Misplaced Spinal Lipiodol: An Analysis of 104 Lipiodol Spinograms

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MUCH DEBATE has taken place concerning the use of lipiodol in the diagnosis and localization of spinal lesions. Little comment, however, has been devoted to misplaced injections of the material, although personal communications reveal that this mishap occurs also in other clinics. Misplaced lipiodol has been noted on our services occasionally, but it remained for one striking case to provoke an analysis of a series of 104 lipiodol spinograms.

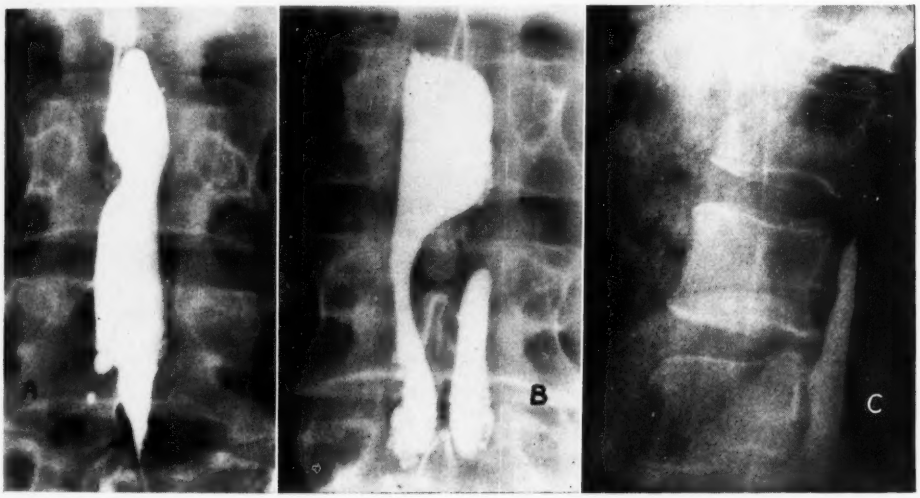

Fig. 1. Lipiodol in the lumbar subdural space. A. Initial fluoroscopy, presenting artefacts resembling space-filling lesions opposite the body of the 4th lumbar vertebra and at the 5th lumbar interspace. B. Appearance later, simulating a midline lesion opposite the 4th lumbar vertebra. C. Lateral view, patient prone, the oil not reaching the anterior border of the spinal canal.

OBSERVATIONS

On Aug. 26, 1940, a patient was seen in consultation who, after several falls, had suffered for a year with intermittent pain in the lower back and in the right and left legs alternately. Neurologic examination revealed no findings suggestive of any localized lesion of the caudal roots, and the picture was atypical for a protruded intervertebral disc, which had been suspected. An air spinogram had been made on Aug. 19, 1940, but this showed no abnormality.

On Aug. 22, 1940, 4 c.c. of lipiodol were injected into the spinal canal. Roentgenograms and fluoroscopic examination showed the oil to move freely through the canal. A defect in the oil column (Fig. 1-A) was seen opposite the fifth lumbar intervertebral disc and another opposite the body of the fourth lumbar vertebra, on the left side, opposite the site of the most severe pain. Since the physical findings were bizarre and the lipiodol picture added confusion, the fluoroscopic and roentgen examination was repeated seven days later. At this time an entirely different picture was obtained (Fig. 1-B). An "island" that could not be filled with lipiodol was found in the middle of the spinal canal, extending from the middle of the body of the fourth lumbar vertebra to the top of the fifth. With the patient on his abdomen, lateral views (Fig. 1-C) of the spine showed that the opaque mass did not settle on the floor of the canal but was separated from it along a wavy border, as if it were elevated from the posterior borders of the fourth and fifth lumbar bodies by an irregular or nodular mass.

[1] From the Buffalo General, Edward J. Meyer Memorial, and Millard Fillmore Hospitals. Accepted for publication in November 1940.

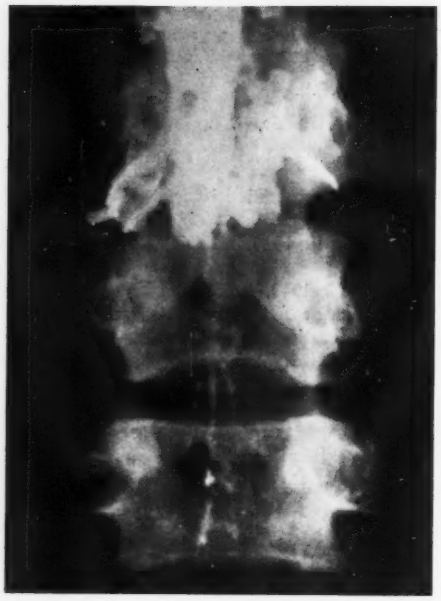

Fig. 2. Lipiodol in the lumbar epidural space. No flow in response to gravity.

A diagnosis was not made and an exploratory laminectomy was advised. On Aug. 29, the fifth lumbar lamina and the lower portion of the fourth were removed. The exposed dura appeared distended, translucent, and yellow. A small opening was made into it and a large amount of lipiodol was expelled. The dural incision was enlarged and all visible oil was aspirated. The arachnoid was then found to be uninjured, retaining the spinal fluid; the lipiodol had been confined within the subdural space. Further spinal exploration revealed no gross abnormality.

In another patient presenting a clinical syndrome rather typical of a protruded intervertebral disc at the fourth lumbar level, an air spinogram on July 20, 1939, was inconclusive. On July 24, 1939, 4 c.c. of lipiodol were introduced by lumbar puncture after a good flow of fluid had been obtained from the needle. On fluoroscopic examination the oil was found to be fixed in an irregular mass at the site of puncture (Fig. 2). After a few days the oil had diffused widely through the spinal canal, extending outward to the sides of the canal and along the nerve roots (Fig. 3). Another lipiodol injection a few days later confirmed the presence of a protruded intervertebral disc and a laminectomy was done. The epidural areolar tissue was found to be moderately edematous and to glisten with lipiodol, which was divided into fine droplets. Removal of the protruded disc relieved the symptoms and the patient had no unpleasant sequelae referable to the misplaced lipiodol.

Fig. 3. Epidural lipiodol several days later than in Fig. 2, showing the wide dispersion of oil around the periphery of the canal, tending to follow nerve sheaths.

INCIDENCE

A review was made of the available lipiodol spinograms at the Buffalo General, Millard Fillmore, and Edward J. Meyer Memorial Hospitals, several cases being taken from the records of colleagues. Altogether 104 cases were analyzed and lipiodol was found to have been misplaced in 8 instances (7.7 per cent). In the 104 cases, the oil had been introduced by cisternal puncture in 13 instances and by lumbar puncture in 91. In the 13 cisternal injections, the oil had been misplaced three times (23 per cent). In 91 lumbar injections, oil had been misplaced five times (5.4 per cent)

ETIOLOGY

On one occasion lipiodol was introduced two days following an air spinogram. When the second lumbar puncture was done, the fluid pressure was found to be low, but the dynamics normal. Four

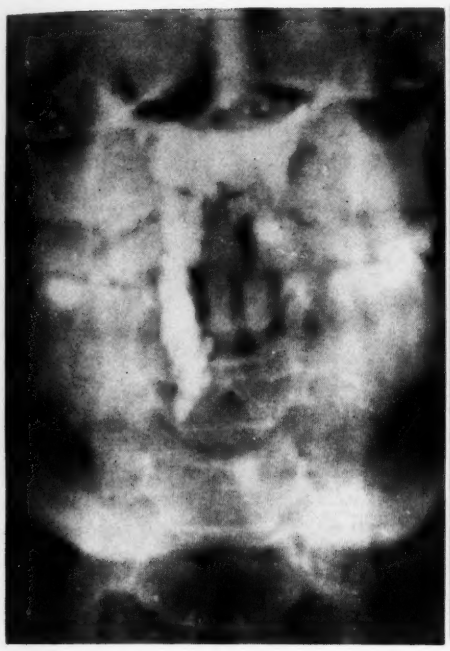

Fig. 4. Epidural lipiodol introduced by cistern puncture.

Fig. 5. Lumbar epidural lipiodol several hours after injection.

cubic centimeters of lipiodol were introduced and fluoroscopic examination demonstrated it in the subdural space. It was believed at the time that the faulty injection was due to the fact that the subdural space was filled with fluid that had leaked through the subarachnoid puncture wound sustained at the time of the air spinogram. This series of cases was analyzed to see if some such factor might be of common occurrence in the cases of misplaced injections.

In one of the 3 examples of lipiodol misplaced at cisternal puncture (Fig. 1) the oil injection was made six hours after a fluid sample had been removed by lumbar puncture; in another (Fig. 2) lumbar puncture had been done two days before cisternal puncture; in the third case (Fig. 4) no previous puncture had been made, the oil being introduced at the time a combined cisternal-lumbar dynamics study was made. In this instance the oil was introduced into the epidural space.

Of 5 cases in which oil had been misplaced by lumbar puncture, 4 had been subjected to air spinography two, three, three, and four days previously. In the fifth case, contributed by a colleague, lipiodol had been introduced at the time of the first lumbar puncture by an intern, who left no note of any technical difficulties encountered.

In 16 cases in which air spinography had been followed by lipiodol injection, the oil was misplaced in 4 (25 per cent). In 29 cases in which the lipiodol injection had been preceded by lumbar puncture alone within three days, the oil was misplaced twice (6.9 per cent). In both of these instances the pathological process present was adhesive arachnoiditis. In one case the oil was introduced six hours and in the other two days after removal of fluid by lumbar puncture.

The constant factor in these examples of misplaced lipiodol was preliminary reduction of spinal fluid pressure either by lumbar puncture or, more commonly, by air spinography. The type of lesion pres-

ent was not a factor in those cases in which the introduction of air was followed by lipiodol. Most of these tests were made to confirm or rule out the presence of protruded intervertebral discs. Lipiodol was misplaced following lumbar puncture alone in two cases of adhesive arachnoiditis. The roentgen picture typical of adhesive arachnoiditis is quite different from that of misplaced lipiodol.

DISCUSSION

It is our opinion that if the fluid pressure has been reduced by previous puncture, the dura may become relaxed and, because of leakage, fluid may be present in either the epidural or subdural space. If a needle is then introduced cautiously, especially as in cisternal puncture, it may only partially penetrate the dura but fluid may flow out. When the heavier lipiodol is then injected under pressure, the dura may be pushed off the point of the needle and the oil may flow into the epidural space. If the subdural space be filled with fluid, the needle may be advanced well into the space, fluid may be obtained freely, and oil may enter. The relaxed arachnoid in this case allows the oil to flow more easily through the subdural space than it does in the epidural space and may lead to faulty interpretation of the roentgen observations. The oil usually does not flow as freely as it does in the subarachnoid space and on subsequent examinations, artefacts are not constant. The oil tends to remain more or less in a mass, however, instead of being widely dispersed.

On the first fluoroscopic examination epidural lipiodol (Fig. 4) is found almost completely fixed, and the flow, if any, in response to gravity is confined to a few droplets that progress in various oblique and vertical directions. After the passage of a few days (Fig. 3) the oil may be found to have diffused widely, in the form of droplets or as a diffuse mass, up and down the canal and outward along the nerve roots.

CONCLUSION

Air spinography, if followed within a short time by lipiodol injection, predisposes to misplacement of the lipiodol.

In patients with adhesive arachnoiditis (and perhaps in others), reduction of spinal fluid pressure by preliminary lumbar puncture predisposes to misplacement of lipiodol introduced by cisternal puncture.

Spinal epidural lipiodol is visualized roentgenologically as a relatively fixed, irregular, opaque mass which, on examination a few days later, tends to appear diffused widely through the canal in the form of minute droplets or as a mass, extending outward along nerve roots.

Spinal subdural lipiodol tends to produce a confusing roentgen picture. The oil flows rather freely but tends to outline defects that are not constant in serial studies. It tends to remain more or less in a mass instead of becoming widely dispersed.

It is recommended that if lipiodol is to be injected after air spinography, a period of ten days be allowed to elapse between the procedures.

SUMMARY

In a series of 104 cases of lipiodol spinography the lipiodol was found to be misplaced in the epidural or subdural space in 8 cases (7.7 per cent). In 91 lumbar injections, there were 5 (5.4 per cent) examples, and in 13 cisternal injections, 3 (23 per cent) examples.

In 16 cases, air spinography was followed shortly by lumbar lipiodol injection, with 4 misplacements (25 per cent).

The roentgen appearance of lipiodol in the subdural space and epidural space is discussed.

Factors tending to reduce the spinal fluid pressure (lumbar puncture or air spinography) predispose to misplacement of lipiodol.

It is recommended that if lipiodol is to be injected after air spinography, a period of ten days be allowed to intervene between the procedures.

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Pathologic Dislocations at the Atlanto-Axial Joint: An Unusual Complication of Rheumatic Fever[1]

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ALTHOUGH DISLOCATION at the atlanto-axial joint is most easily recognized roentgenologically, very little mention of it is made by roentgenologists, most of the reports having come from pediatric and orthopedic literature. In 1935, Hess, Bronstein, and Abelson collected 22 cases from the literature, and added two cases of their own. A tabulation of a group of these cases (Table I) shows an approximately equal sex distribution with the great majority occurring in children between six and twelve years of age. The predominant pathologic condition which accompanies the lesion is an acute inflammatory process in the nasopharynx. According to the earlier literature, tuberculosis was apparently more common as a provocative lesion. Less frequently seen are dislocations resulting from a rheumatic or arthritic process. As with pathologic fractures, there may be a history of some trivial injury, but the trauma is always of quite a different magnitude than that required to produce a dislocation of normal structures. In contrast to pathologic dislocations, for which the outlook as to life is good, traumatic dislocations at the atlanto-axial joint are usually fatal.

The typical history of these cases is an upper respiratory infection of more than usual severity in a preadolescent child, followed a week or two after the onset of the illness by stiffness and immobility of the neck. This comes on insidiously and is at first interpreted as an ordinary consequence of inflammation of the pharynx and neighboring lymph nodes. However, the head soon becomes fixed in a characteristic position, tilted slightly forward and downward with the chin pointed to one side. A firm resistance is encountered in attempting to bring the chin to the midline.

In addition to the striking attitude of the patient, the examiner will note an unusual prominence of the spinous process of the axis on palpation of the back of the neck, and palpation of the posterior pharynx through the mouth will reveal the prominence of the anterior arch of the atlas. The roentgen findings are characteristic and are best shown by detailed films of the upper cervical spine exposed in the lateral projection and in the anteroposterior projection through the open mouth. The lateral film shows the anterior arch of the atlas to lie anterior to its normal position in close approximation to the odontoid process of the axis, while the film exposed through the open mouth shows a loss of spacing between the lateral mass of the atlas and the body of the axis on one side, with overlapping of these structures.

The preferred treatment is prolonged traction and extension and the results are usually good if the condition is recognized and treated soon after the onset. Often the functional result is excellent, although some anatomical deformity remains.

R. R., a nine-year-old boy, was admitted to the Children's Hospital of Michigan on Sept. 9, 1939, complaining of pain in the neck with limitation of motion.

The patient had first been seen in the Out-patient Department on Dec. 1, 1932, with a mild "cold" and earache. Later a mastoidectomy and tonsillectomy were performed elsewhere. The child was next brought to the hospital on July 28, 1938, with a history of pains in the ankles, knees, and shoulders, usually associated with attacks of hay fever in the summer months. A diagnosis of rheumatic fever was made.

At an Out-patient visit on June 10, 1939, there was a complaint of severe migratory joint pains for one month. The attack was similar to the one in the previous year, and the ankles and knees were swollen and tender. In addition the neck was stiff and painful. The throat appeared normal and no cervical

[1] From the Department of Roentgenology, Children's Hospital of Michigan. Accepted for publication in October 1940.

TABLE I: PATHOLOGIC DISLOCATION OF THE ATLANTO-AXIAL JOINT: CASES FROM THE LITERATURE

Author	Year	Sex and Age	Disease	Treatment	Result	
					Immediate	Late
Wittek, A. (1)	1908	M 11	Carious tooth with periostitis	Extension with collar	Good symptomatically, not roentgenologically	
Ely, L. W. (2)	1911	M 13	Rheumatism and trauma			
Jacobs, C. M. (3)	1918	M 17	Osteopathic manipulation	Manipulation without anesthesia	Unsuccessful	
				Prolonged traction	Good	Good 8 weeks
		M 5	Fever	Hyperextension and plaster	Good	
		M 8	Rheumatism	Manual traction with anesthesia	Temporary cessation of respiration	
Grisel, P. (4)	1930	F 8	Tonsillectomy; fever	Prolonged extension and traction		Good 9 years
		F 9	Rhinopharyngitis	Same		Good 5 years symptomatically, but with persistent deformity
Desfosses, P. (5)	1930	F 8	Nasopharyngeal grippe	Prolonged extension	Good	
Berkheiser, E. J., and Seidler, F. (6)	1931	F 8	Arthritis	Extension and traction	Poor	
		F 10	Scarlet fever and diphtheria	Traction	Good	
		M 9	Acute coryza	Traction	Good	
		M 11	"Cold" and tonsillitis	Traction	Good	
		F 9	"Flu"	Forcible reduction	Good	
Swanberg, H. (7)	1931	M 22	Measles, tonsillitis, and trauma	Forcible traction	Poor	Poor
Jones, R. W. (8)	1931	F 16	Tuberculous adenitis and trauma	None	Death	
Jones, A. R. (9)	1932	M 10	Tonsillectomy	Prolonged traction and plaster		Fair as to deformity; good as to symptoms
Stammers, F. A. R., and Frazer, P. (10)	1933	M 30	Spondylitis deformans	Immobilization without reduction	Fair	
Hess, J. H., Bronstein, I. P., and Abelson, S. M. (11)	1935	M 6	Scarlet fever with suppurative cervical adenitis			
		F 11	Cold			
Chesterman, J. T. (12)	1936	F 10	Tonsillitis	Traction and collar	Good	
Frank, I. (13)	1936	M 9	Retropharyngeal abscess	Extension	Good	
Steele, G. H. (14)	1937	M 7	Adenoidectomy and purulent pharyngitis	Immobilization without reduction	Good functional result with deformity	

Not included in this series is the group of nine cases reported by Rankin, where trauma was considered to be the principal factor in the dislocation, although in a number the trauma was slight and there was also evidence of a pathologic process. There is also the remarkable case, reported by Brav, of the man apparently capable of a voluntary dislocation.

masses were palpable. The cardiac rhythm was normal and there were no murmurs. The electrocardiogram was normal and the heart was found to be at the upper limits of normal in its transverse diameter on the teleroentgenogram (cardiothoracic ratio 0.51). Skin tests revealed a hypersensitivity to many allergens, but particularly to ragweed pollen. In September the pain in the neck was very severe and hospital admission was advised.

The patient was quite fat, weighing 115 lb., with a height of 58 1/2 inches. The fat distribution was of a female type. The penis was small and only one testicle was palpable in the scrotum. The head was held with the chin pointing to the left, and attempts at rotatory motion were painful, although flexion and extension could be carried out. The throat could not be examined because of the pain. The rest of the examination, which included the heart, was negative. The temperature, pulse, and respirations were normal.

Blood studies showed: hemoglobin 14.5 gm. per 100 c.c.; white cell count 18,000 with a predomi-

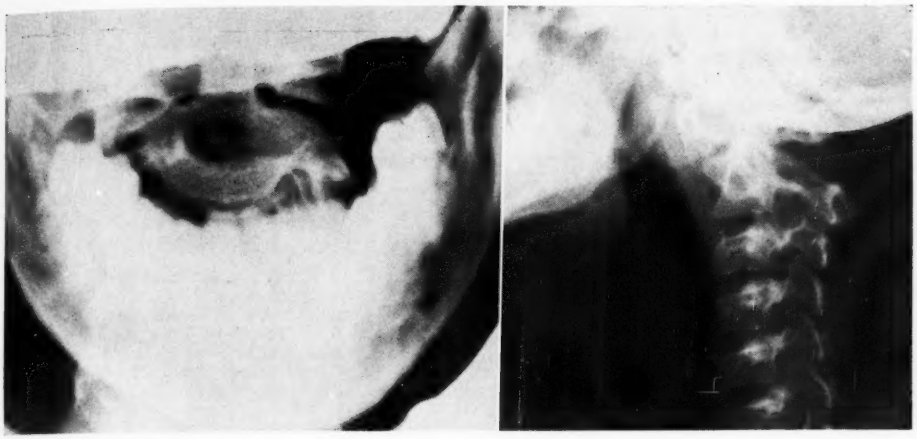

Fig. 1. Rotary dislocation at the atlanto-axial joint: roentgen studies made on Oct. 12, 1939. In the anteroposterior view the right lateral mass of the atlas is seen to be displaced forward and downward overlying the body of the axis. In the lateral view the anterior arch of the atlas is seen to be displaced anteriorly with respect to the odontoid of the axis.

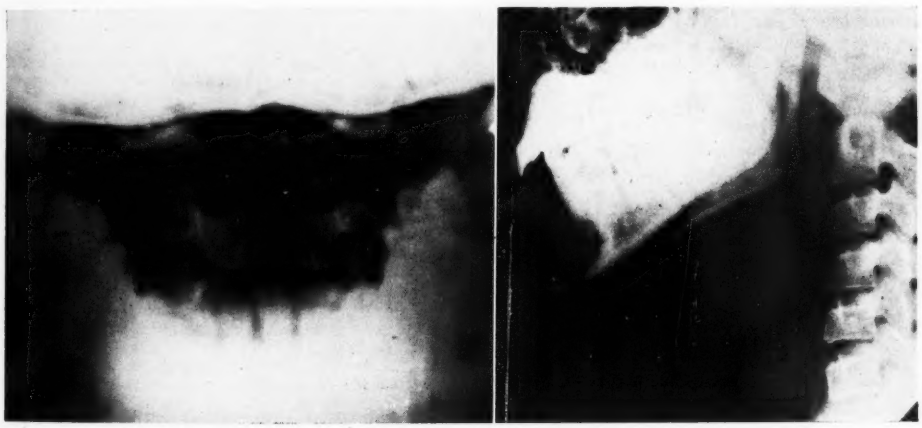

Fig. 2. Roentgenograms taken on April 23, 1940, following the reduction of a second dislocation. There is a minor deformity with slight displacement of the atlas anteriorly and toward the right side and some narrowing of the intervertebral disc cartilage between the right lateral mass of the atlas and the body of the axis. In spite of the deformity, however, there is no complaint or limitation of movement.

nance of young polymorphonuclear forms. The urine showed no abnormalities. The tuberculin and Kahn tests were negative. The electrocardiogram was again normal.

X-ray examinations of the cervical spine were carried out on Sept. 16 and Oct. 12, but the true nature of the condition was not revealed until the examinations could be made through the open mouth, on Oct. 13. This revealed the dislocation at the right side of the atlanto-axial joint with no demonstrable fracture or other abnormality in the osseous structure (Fig. 1).

Salicylates were administered and traction was applied to the head, with much relief of pain. A high-pitched moderately loud systolic murmur appeared at the apex of the heart, and this persisted for many months. At times a presystolic murmur was also heard and there was thought to be definite rheumatic involvement of the mitral valve. The electrocardiogram remained normal throughout.

On Oct. 19, 1939, ice-tong calipers were applied and there was gradual improvement in the deformity of the cervical spine with radiographic evidence of restoration of the normal relationship of the axis and atlas on Oct. 31. On Dec. 2 the neck was put in a restraining collar. The patient was allowed up and was discharged to a convalescent home.

X-ray studies on Jan. 16, 1940, showed a recur-

rence of the dislocation and the patient was again admitted Jan. 23 with an exacerbation of the rheumatic fever, involving the right hand. Halter traction was not effective in reducing the dislocation and on Feb. 9 the ice-tong calipers were reapplied with eight pounds traction. There was improvement in the deformity as shown by x-ray films on Feb. 13. Further studies were carried out between Feb. 26 and July 10, with no definite change demonstrable during that time. Figure 2 (April 23, 1940) illustrates the slight residual deformity. The calipers were removed on April 8 and the patient was kept on a frame with the neck extended. There was free rotation in both directions without symptoms and on July 9 he was allowed up. He was finally discharged on July 31 with good movement of the neck in all directions and without complaint.

With regard to the cardiac status, an examination on Feb. 2, 1940, revealed a prolonged, harsh, widely transmitted systolic murmur, and there was thought to be an aggravation of the rheumatic carditis since the former admission, with a possible involvement of the mitral valve. No electrocardiographic changes were demonstrable, however, and teleroentgenographic studies reported on July 10, 1940, revealed no abnormality in the size or shape of the heart (cardiothoracic ratio 0.46).[2]

CONCLUSIONS

An unusual complication of rheumatic fever is reported in a ten-year-old boy. During an exacerbation of the disease, and without a history of trauma, a rotary dislocation occurred at the atlanto-axial joint. Reduction was accomplished by skeletal traction, but there was a recurrence during another exacerbation of the rheumatic fever. Skeletal traction was again effective in reducing the deformity and the dislocation has not recurred during the following six months. In spite of a slight residual deformity, there is free and painless motion of the neck in all directions.

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[2] The patient was examined again on May 17, 1941, and at that time was without complaint. The roentgen studies of the neck and chest were essentially negative.

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Roentgen Diagnosis of Intra-Uterine Hydrocephalus[1]

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CONSIDERABLE responsibility rests with the roentgenologist who is called upon to supply a diagnosis in a suspected case of intra-uterine hydrocephalic fetus. This hazard is enhanced by its very rarity, which curtails the acquisition of experience in dealing with such cases. Any formulated method of roentgen study, if not too complicated, should be of great aid.

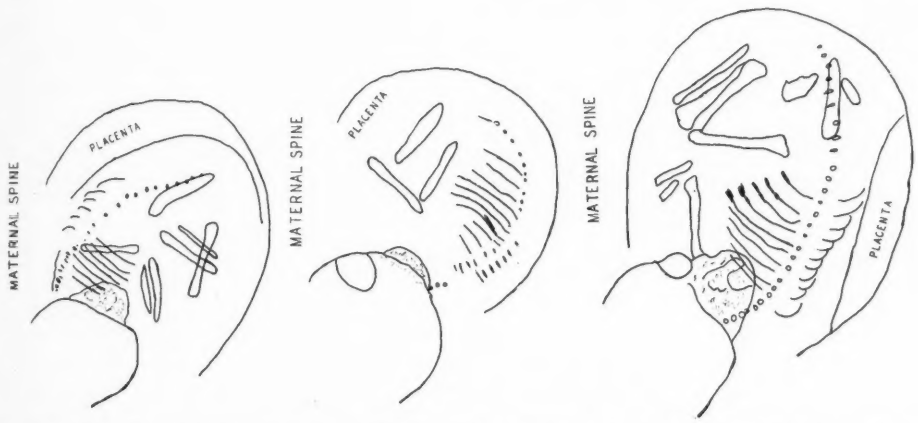

Fig. 1. Tracings from skiagrams of a normal fetus (left), hydrocephalic fetus (center), and giant fetus (right) in identical scale.

The method to be described here presupposes the more or less routine use of the lateral soft-tissue technic in the study of pregnancy. To this is added a study of the obstructed labor by the grid method, in which the roentgen pelvimeter devised at the University Hospital is employed. This gives an 8 × 10 inch film showing the fetal head framed in the inlet. These two methods complement each other, and in our opinion are all that is necessary for an adequate study of the fetal-maternal-pelvic relationship in labor.

In a case of suspected hydrocephalus the lateral film showed the skeleton of a fairly large fetus without spina bifida but a very large head. The height of the fundus, measured from the symphysis pubis (1 cm. below the apex of the bone), was 31 cm. at term. This was 1 cm. greater than the average and indicated a large fetus. There was no hydramnios. The head was hard and measured through the abdominal wall 14 cm. in transverse diameter. Though it was not certain which diameter this represented, it nevertheless indicated a large fetal head. Following twenty-four hours of fairly hard labor and twenty hours after rupture of the membranes, the fetus was delivered by low cervical cesarean section.

The child breathed without difficulty. It weighed 9 pounds and 8 ounces, but had the body of about an 8-pound normal infant, as ascertained by actual comparison. The head, which was relatively far too large for the body, had the bulging forehead and deep set eyes of a typical hydrocephalic. The measurements, compared with those of a giant fetus recently

[1] From the Department of Roentgenology and the Department of Obstetrics and Gynecology, University of Georgia School of Medicine. Accepted for publication in December 1940.

Fig. 2. Copying device, showing glass plate about 12 inches from the lighted film and peep hole 16 inches from the glass.

seen and with those of a normal 7 pound 4 ounce fetus, are shown in the accompanying table. Skiagrams of the three infants *in utero* are reproduced, in identical scale, for comparison (Fig. 1). By copying the radiographs thus reduced to equal scale, it is possible to recognize the hydrocephalus immediately and without question.

The copying device is extremely simple and easily made (Fig. 2). It consists merely of a piece of plain glass held parallel and about 12 inches away from the lighted film, with a peep hole fixed about 16 inches from the glass. The outline is transcribed to the glass by means of a wax pencil and from the glass is traced on a sheet of paper.

The lateral view offers two advantages over the flat plate. (1) It shows the position of the fetus in relation to the anterior and posterior segments of the uterus, which is important in the diagnosis of posterior presentation, and (2) in most cases it reveals the location of the placenta on the anterior or on the posterior wall, showing whether it is high or low in the uterus. It is definitely useful in the diagnosis of premature separation of the placenta, showing marked thickening of the placental shadow with attendant crowding of the fetus toward the opposite wall of the uterine cavity.

TABLE I. COMPARATIVE MEASUREMENTS OF A NORMAL, HYDROCEPHALIC, AND GIANT FETUS

	Normal (7 lb. 4 oz.)	Hydrocephalic (9 lb. 8 oz.)	Giant (14 lb. 7 oz.)
Biparietal (B. P.)	9.5 cm.	11.5 cm.	10.75 cm.
Fronto-occipital (F. O.)	12	15	
Suboccipito-bregmatic (S. O. B.)	9.5	12	11
Diameter shoulders	9.5	11.5	16.5
Diameter iliac spines	8	8.5	
Circumference of head	30.5	43	
Crown-heel	49	52	62.5
Crown-rump	39	40	

University Hospital, Augusta, Ga.

CASE REPORTS

Leiomyosarcoma of the Duodenum[1]

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The reporting of any pathological rarity is apt to stimulate others to a like effort and the rarity tends to become more commonplace. The findings in each new case aid in establishing a fairly recognizable symptom-complex and increase the chance of correct diagnosis when the condition is next encountered. For this reason we are reporting the eighth known primary leiomyosarcoma of the duodenum, the previous seven having been reported by von Salis (1), Brdiczka (2), Andersen and Doob (3), Silverstone (4), Seymour and Gould (5), Foshee and McBride (6), and Harrington (7).[2]

Tumors of the duodenum are not rare if every tumor which involves the duodenum, directly or indirectly, is included, but in proportion to such common disorders as duodenal ulcer, duodenal tumors are indeed uncommon. In a series of 20 cases of abdominal tumor reported by Weintraub and Tuggle (8) there were 18 showing x-ray evidence of duodenal involvement, but only 2 of these were primary neoplasms (cancer) of the duodenum. Kellogg and Kellogg (9) reported a case of pedunculated adenoma of the duodenum and in a review of the literature brought out several points of interest relative to duodenal tumors in general. In one series of 119 benign tumors of the small intestine only 4.2 per cent were in the duodenum. In another series of 151,784 deaths from all causes 0.03 per cent were due to duodenal neoplasms. Of 7,005 malignant growths of the alimentary tract, 4,288 were in the stomach, 1,204 in the rectum, 1,011 in the esophagus, 482 in the large intestine, and only 20 in the small intestine including those in the duodenum, but how many involved the duodenum alone is not stated. These writers attribute the rarity of metastatic tumors in the duodenum to the direction of the lymphatic flow and believe that if a malignant neoplasm does occur in the duodenum it is more likely to be primary there. The symptomatology of duodenal tumor, they conclude, depends on whether it occurs in the first part, in the second part about the ampulla of Vater, or in the third part. They suggest, in line with the observations of von Salis, a possible point of differentiation between carcinoma and sarcoma of the duodenum, in that carcinoma, arising from the mucosa, tends to produce an annular constriction of the lumen, while sarcoma, arising from the submucosa and muscularis, would tend to grow longitudinally and be less apt to obstruct the lumen. They believe that roentgen examination constitutes the most important element in the diagnosis of a duodenal tumor. Mayo (10) found that leiomyosarcoma makes up less than 10 per cent of malignant lesions of the duodenum.

The symptoms of duodenal tumor depend in large part on their location, on whether or not there is obstruction (*a*) of the biliary tract or (*b*) of the intestinal tract (duodenum). The picture may be complicated by extensions into surrounding tissues and by metastases; degenerative accidents may befall the tumor, such as abscess formation, perforation, or hemorrhage. Obviously such effects or degenerative changes may precipitate a crisis in the course of the disease and require prompt surgical intervention.

Case Report

Mrs. J. M. N., age 65, was first seen on July 26, 1939. She was a nervous, somewhat peculiar person, from whom it was difficult to get any sort of a connected story. She complained of shortness of breath, of weakness, and of nausea. Her symptoms were not unlike those of cardiac failure, but her pallor suggested internal bleeding. She had never been in very good health, and for many years had experienced short periods of indigestion, when it seemed easier to vomit her food than to attempt to digest what she had just eaten. At such times she suffered from headache. She had never been very acutely ill and had had only one minor pelvic operation. She had never been pregnant and had long since gone through a normal menopause. There was nothing of significance in her family history except that almost every one of her relatives had some sort of mental peculiarity.

The present illness, the patient thought, dated back about three months, when the spells of weakness, nausea, and shortness of breath seemed to become more frequent. She had noticed on several occasions that her stool was dark but paid no special attention to it, assuming that the discoloration was due to the iron in the medicine she was taking, a preparation of beef, iron, and wine. At no time had she vomited blood or passed fresh blood per rectum. She thought she had lost some weight but had no idea how much. Her usual weight was about 120 pounds.

Physical examination revealed a marked scoliokyphosis. The complexion was waxy, with the faintest lemon tinge. The head and neck were essentially negative except for a refractive error and a number of missing teeth. The chest was narrow with an increase in the anterior-posterior diameter and the heart was well over to the right side.

[1] Accepted for publication in February 1941.

[2] Since preparation of this report, C. W. Mayo (10) has reported two additional cases.

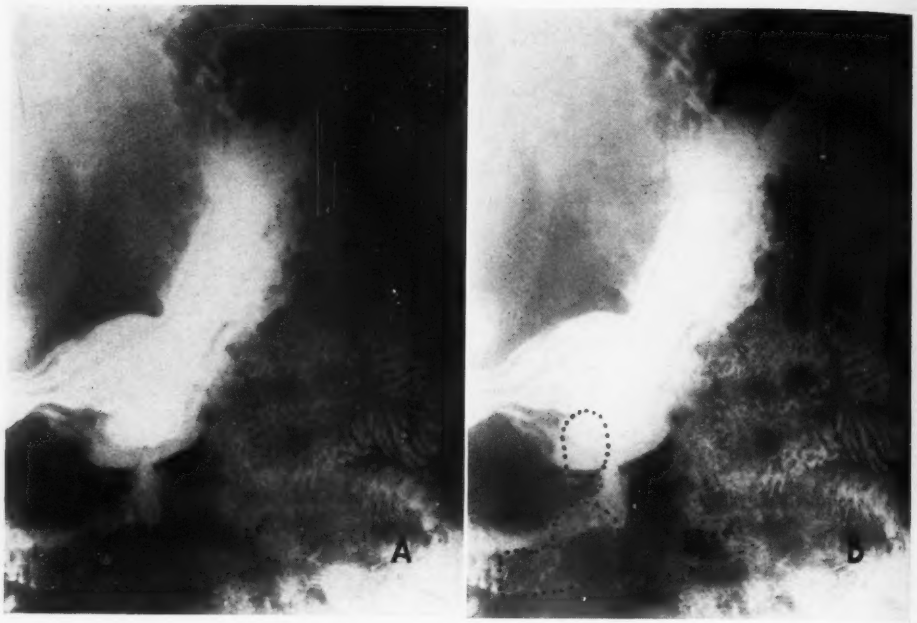


Fig. 1. Stomach and duodenum, slight left anterior oblique position. The nodular tumor involving the third portion of the duodenum is well seen in A. The normal mucosal pattern is completely lost in this section of bowel. In B the general appearance of the tumor as seen at fluoroscopy is shown by the dotted lines.

Neither heart nor lungs showed any trouble *per se* beyond generalized arteriosclerosis. The blood pressure was 140/90, temperature 98.6° F.; the pulse rate was 140, though the previous evening it had been only 120.

Owing to the scoliosis, the left lower ribs dipped down behind the crest of the ilium and the lumbar spine protruded forward and into the right half of the abdomen. There was no localized tenderness. The liver was not enlarged. On deep palpation a vague mass was felt in the right upper abdomen. This mass was freely movable, so much so that it was not successfully outlined. Indeed, on subsequent examinations it sometimes appeared doubtful if there was actually a mass there. Manipulation of the abdomen produced some nausea. The extremities were normal.

Considering the patient's pallor, and in spite of the absence of any other evidence except the increase in pulse rate, it was felt that she was bleeding internally and she was urged to go to the hospital. This she refused to do. During the night of July 27–28 she had a bowel movement, passing an enormous, dark-colored, foul smelling stool, which seemed so offensive to her that none of it was preserved for examination. Following this she felt and appeared better than on the day before. Again she refused to enter the hospital for study and treatment. On July 31, 1939, she became worse and passed a large black stool, which was found on examination to contain a large amount of both occult and free blood, mucus, undigested food particles, and crystals. There were no concretions, amebae, ova, or parasites.

The patient now consented to go to the hospital and there her physical examination was completed. A vaginal examination disclosed a vagina too small to admit even one finger. Rectal examination was negative and the uterus, which was clearly outlined through the rectum, was quite small. There were no palpable pelvic masses. Sigmoidoscopy was done twice, with negative findings. From these examinations it was definitely felt that the lesion was higher up, and that the bleeding was not of pelvic origin.

The laboratory work on admission showed the urine to be normal and the Wassermann and Kahn tests to be negative. The blood count was surprising in that the patient was even more anemic than she appeared. The hemoglobin was 32 per cent. The red blood count was 2,440,000 and the white cell count 6,850, with neutrophils 88 per cent, lymphocytes 9 per cent, and monocytes 3 per cent.

In the hospital the patient improved subjectively and, as her strength permitted, first one and then another examination was performed.

She was put on a regular diet and only once or twice vomited her food. Her stools occasionally were dark but never definitely tarry. On Aug. 5 and again on Aug. 22, she was given 500 c.c. of citrated

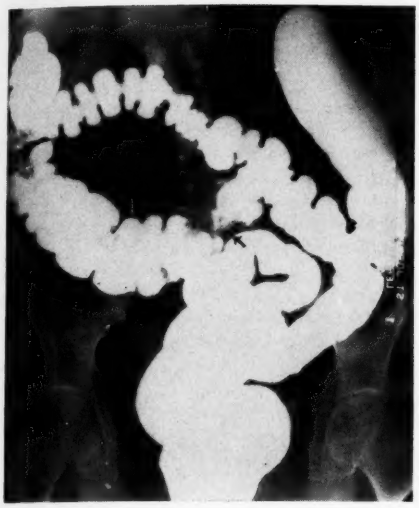


Fig. 2. Colon filled by opaque enema, showing the mesial displacement or non-rotation of the lower ascending portion and the deformity of the latter just above the cecum. No tumor was palpable in this region; the deformity was not constant in its shape or length.

blood intravenously. The hemoglobin rose to 68 per cent and the red blood cells to 4,240,000.

The findings on a gastric analysis were so bizarre that for a while we were at a loss to explain them, especially the presence of a large amount of pus. The report follows: Fasting specimen: 25 c.c. white liquid; mucus; occult blood, heavy trace; free acid 0°; total acid 10°. Fifty c.c. of 7 per cent alcohol given. Thirty-minute specimen: 7 c.c. white, thick, mucoid liquid; occult blood, good trace; free acid 0°; combined 10°; total 10°. Sixty-minute specimen: 10 c.c. white mucoid liquid; some mucus; occult blood, faint trace; free acid 0°; combined 10°; total 10°. Ninety-minute specimen: 8 c.c. white liquid; some mucus; occult blood, very faint trace; free acid 0°; combined 10°; total 10°. Lactic acid not increased in any specimen. Microscopic examination: no Boas-Oppler bacilli seen; filled with gram-positive diplococci and streptococci; rare gram-negative microorganism; very many pus cells.

Repeated roentgen examination showed the heart to be normal in size and position and the lung fields clear.

The esophagus was normal. At the cardiac end of the stomach was a 4-cm. hiatus hernia. The remainder of the stomach showed no organic defect. The proximal half of the duodenum appeared normal. The mucosa in the entire distal half was deformed and irregular. In the third portion of the duodenum was an oval filling defect about 6 cm. in length. No mass was palpable.

At five hours no gastric residue was noted; the barium was in the terminal ileum. Examination of the colon by opaque enema revealed no evidence of organic disease in the distal two-thirds. The lower ascending colon was displaced mesially, the cecum being on the left side of the spine. There was deformity of the ascending colon just above the cecum, without palpable tumor. This deformity was not constant and its significance was considered doubtful.

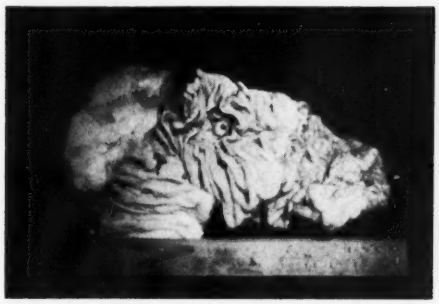


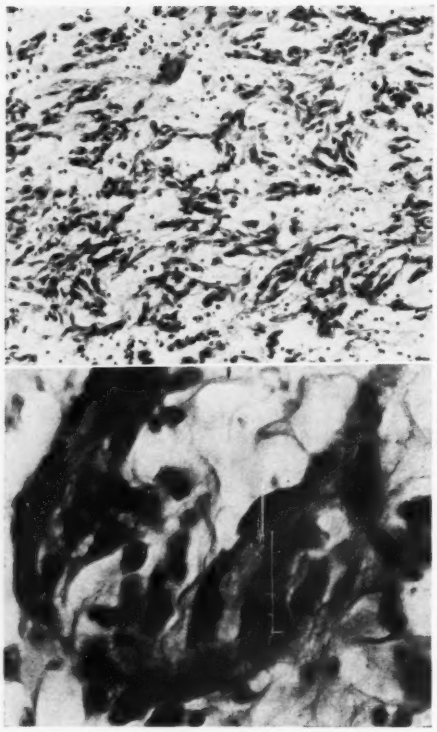
Fig. 3. Sessile tumor of duodenum, longitudinal view.

Re-examination of the alimentary tract after a few days confirmed the presence of the constant irregularity of the third portion of the duodenum, with local filling defects, but did not disclose any definite lesion elsewhere in the bowel.

In view of the probable presence of a bleeding duodenal tumor, surgery was undertaken Aug. 25, 1939. The preoperative diagnoses were: (1) hiatus hernia, (2) tumor of the middle and distal portions of the duodenum, with recurrent hemorrhage, and (3) possible neoplasm of the cecum. The last diagnosis was based on the fact that the cecum was always fixed and apparently deformed. In none of the examinations could it be freed and palpated satisfactorily to exclude involvement by tumor.

At operation the stomach appeared to be entirely normal, as was the first part of the duodenum. A firm, freely movable tumor about the size of an orange, and somewhat lobulated, was discovered in the second and third parts of the duodenum. It was covered by numerous distended veins. This tumor lay distal to the common duct. It protruded into the lumen of the duodenum for quite a distance, its growth having taken place longitudinally and into the mesentery of the duodenum. It lay against the head of the pancreas but was not attached to it: There did not appear to be any involvement of the liver or regional lymph nodes. Along the jejunum and the upper ileum were a number of small nodules. These nodules were subserous, and quite firm. The largest was removed for biopsy.

Contrary to expectation the cecum was found to have a very long mesentery and to be freely movable to almost any part of the abdominal cavity. There



Figs. 4 and 5. Photomicrographs of the excised tumor. The low-power photomicrograph shows typical cells of leiomyosarcoma and edema of the stroma. The high-power magnification shows tumor giant cells.

was no evidence of malignancy in the cecum, colon, or sigmoid. The appendix appeared normal. The uterus and adnexa were normal. The kidneys and spleen were normally placed and not remarkable.

It was decided that the bleeding probably came from that part of the tumor that was in the third portion of the duodenum, as a defect in the surface of the tumor was felt through the bowel wall. Since the tumor was freely movable it was decided to resect it. The pyloric end of the stomach and the duodenum up to a point beyond the area of involvement were resected *en masse*. The common duct was isolated and tied, and as far as could be determined the pancreatic duct was not disturbed. The distal stump of the stomach was closed in the usual manner. The duodenum was tied off and the end invaginated. All of the raw surfaces and the denuded portion of the pancreas were completely peritonealized. A posterior gastro-enterostomy was performed. A loop of jejunum distal to the gastro-enterostomy was drawn up without tension through the mesocolon and a cholecystojejunostomy was done. Stay sutures were placed here and there to prevent either kinking or herniation. Closure was without drainage.

Dr. C. E. Smith, the pathologist, made the following report:

"The specimen consists of the pyloric region of the stomach and part of the duodenum. In the duodenum, 3 cm. distal to the ampulla of Vater, is a polypoid, slightly lobulated, kidney-shaped tumor, 8 × 3 cm. Except for the lobulations the surface is smooth; this part of the tumor is covered by a thin mucous membrane. The tumor has extended through the wall of duodenum and formed a mass 5 cm. in diameter which was adherent to the pancreas. Cut section through various parts of the tumor shows a boggy, homogeneous, cellular tumor. There is central necrosis in the part of the tumor which lies between the duodenum and pancreas.

"Microscopic examination shows a thin layer of mucous membrane covering the tumor, with diffuse infiltration of lymphocytes and plasma cells. The tumor is composed of large spindle-shaped cells, which vary considerably in size. There are multinuclear giant cells and a moderate number of mitoses. There is marked edema in large tissue spaces between the cells. There are a number of large and small blood vessels in the tumor."

Diagnosis: Leiomyosarcoma of duodenum.

The patient survived the operation two days, to die of myocardial failure. There was no postoperative distention, intra-abdominal distress, or vomiting, except terminally, when a small amount of bile-stained material was vomited. An autopsy could not be obtained.

SUMMARY

A case of duodenal leiomyosarcoma is reported, the eighth to be recorded to date. The tumor was diagnosed preoperatively as a duodenal neoplasm, its bulky appearance suggesting the possibility of sarcoma. It was removed *in toto*, but the patient survived the operation for only two days.

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Report of Two Cases of Carcinoma of the Jejunum[1]

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Because of the relative rarity of carcinomata of the small intestine, two cases encountered in the x-ray laboratory at the Buffalo General Hospital within a three months' period seemed to be of sufficient interest to report. In the first case we were able to demonstrate the growth roentgenologically. In the second the obstruction was more complete and the lesion could not be visualized with barium because of the intestinal contents ahead of the barium meal.

Tumors of the small bowel fall into two major classes, benign and malignant. Benign tumors include fibroma, adenoma, lipoma, and myoma, all of which are extremely rare. Malignant tumors include carcinoma and sarcoma.

In a series of cases published by Mayo and Rankin in 1930 which included all gastro-intestinal carcinomata encountered up to that time at the Mayo Clinic they reported only 0.062 per cent as occurring in the small bowel. Of a total of 55 small bowel carcinomata, 15 were in the duodenum, 21 in the jejunum, 14 in the ileum, 3 were multiple, and in 2 instances the site was undetermined. In reviewing these cases it was found that males were more frequently affected and that the average duration of symptoms prior to discovery of the lesion was fourteen to fifteen months. The symptoms most commonly encountered were as follows: intermittent obstruction symptoms, recurring with increasing severity and frequency; gastric distress between attacks; constipation, or occasionally intermittent diarrhea and constipation; progressive weakness and weight loss. Cachexia is usually quite severe and obstructive phenomena such as distention and reverse peristalsis may be noted on physical examination. A mass may or may not be palpable in the abdomen. Occult blood usually is detected in the stools, and secondary anemia may be pronounced.

Growth may develop on the basis of a degenerating polyp or may be annular in type, as so often occurs in the colon. Metastases are common and occur early, probably because of the abundant lymphatic supply and the activity of the small bowel. The prognosis is poor. In the series of Mayo and Rankin the longest duration of life was three years and the average for the 55 cases was less than one year.

The roentgen demonstration of carcinomata of the small bowel depends on careful screen examination of the passage of an opaque meal through the small intestine plus roentgenograms of any suspicious findings. Akerlund states that such an examination should be carried out in any patient with persistent melena in whom the stomach and colon are negative. He gives the following primary local roentgen signs of tumor infiltration in the small bowel: obliteration of normal rugae relief; stiffness and inflexibility of the intestine, with tenderness on pressure and palpable resistance; filling defect; niche formations, persistent patches of opaque substance; prestenotic formation of "pseudo-diverticula."

REPORT OF CASES

CASE 1: Miss E. K., a white woman, aged 64, was admitted March 20, 1940. She had had no complaints up to seven weeks prior to admission, when she began to experience gradually increasing constipation. She gave a four weeks' history of emesis of retention type, usually occurring once daily. Other complaints were increasing thirst and hunger and a loss of 6 pounds in weight. There was no abdominal pain.

Except for marked dehydration the physical findings were negative. Sigmoidoscopy revealed nothing of significance. The laboratory findings were as follows.

Urine: Albumin 2 plus and a few granular casts.

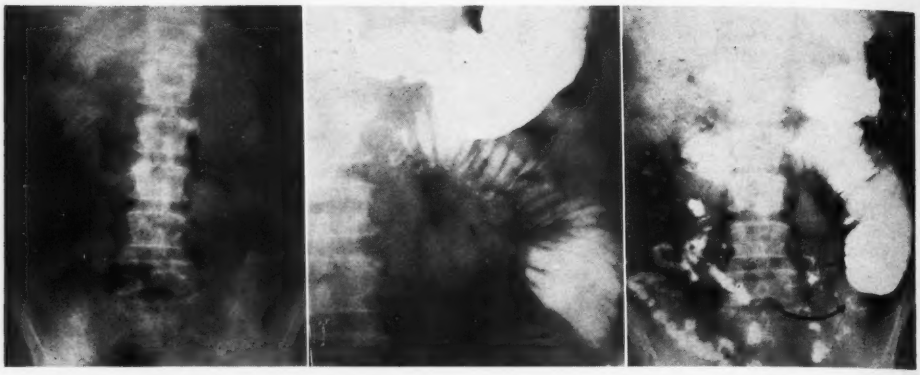
Blood: red cells, 4,700,000; hemoglobin, 100 per cent; white cells, 13,000 with normal differential count; urea nitrogen, 38 mg. per cent; sodium chloride, 465 mg. per cent.

The stool was not examined.

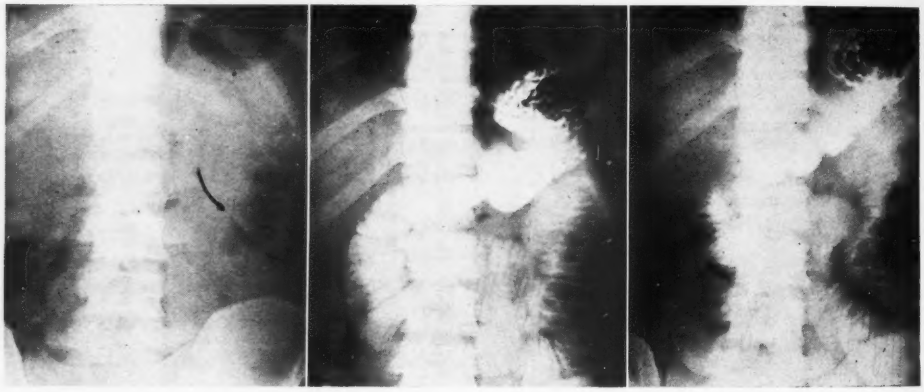
A flat film of the abdomen showed one isolated loop of dilated small bowel in the left upper quadrant. With barium the esophagus, stomach, and duodenum appeared normal. The upper jejunum was greatly dilated, the dilatation ending in an irregular fixed narrowing a short way below the ligament of Treitz. No barium forced its way through this narrowing. At five hours the stomach contained considerable barium and the jejunum was dilated with barium proximal to the obstruction. Some barium had passed distal to the obstruction. At the end of forty-eight hours there still was a small amount of barium just proximal to the obstruction. Our interpretation of the roentgen findings was a malignant intrinsic tumor of the upper jejunum causing a partial obstruction.

At operation, March 26, 1940, there was found, 6 inches below the ligament of Treitz, an annular tumor completely encircling the jejunum. Proximal to the tumor the jejunum was edematous and dilated to four times normal size. Distally it was collapsed and normal in appearance. The tumor was resected and lateral anastomosis was carried out. One metastatic nodule in the omentum was removed.

[1] Accepted for publication in September 1940.



Figs. 1–3. Case 1. Left: Preliminary plain film; arrows indicating small loop of jejunum dilated with gas and contents. Center: After barium by mouth; arrow indicates irregular fixed narrowing in jejunum, interpreted as a malignant lesion; proximal jejunum and duodenum markedly dilated. Right: Five-hour film; arrow again pointing to site of lesion; jejunum and duodenum still markedly dilated and large residue in stomach. Some barium has passed the obstruction and is scattered through the small bowel.



Figs. 4–6. Case 2. Left: Preliminary plain film; arrows indicating loop of small bowel dilated with gas. Center: After barium by mouth, showing duodenum and upper jejunum dilated with barium mixture. Right: Two-hour film, showing duodenum and upper jejunum still dilated with barium. No barium has passed into lower bowel.

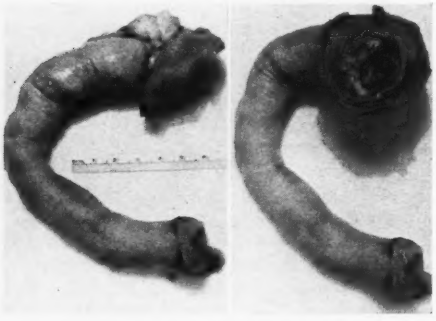


Fig. 7. Case 1. Photograph of surgical specimen showing annular nature of the lesion, the narrowing of the lumen of the jejunum, and the dilatation of the proximal portion.

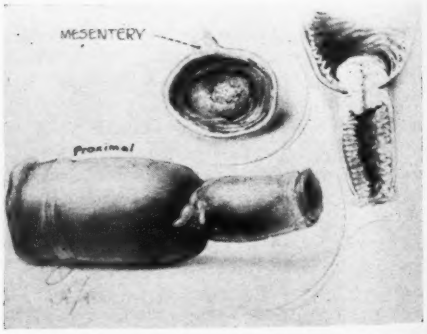
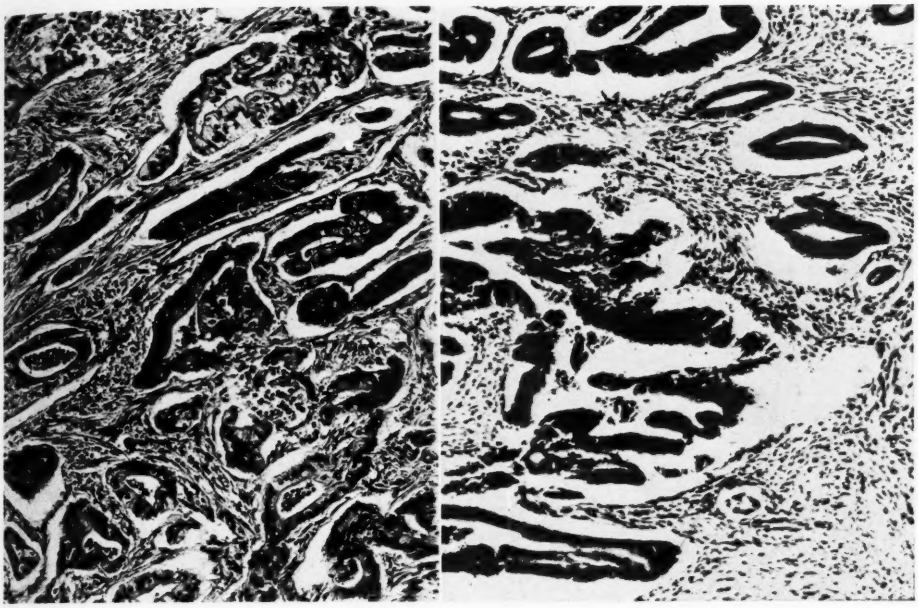


Fig. 8. Case 2. Drawing of surgical specimen showing annular constricting carcinoma almost completely occluding the lumen of the jejunum.



Figs. 9 and 10. Microscopic sections from tumors removed at operation, Case 1, left; Case 2, right.

Microscopic examination showed an infiltrating adenocarcinoma of high maturity, with invasion of all layers.

The postoperative course was uneventful and the patient was discharged on April 25, 1940.

CASE 2: Mr. W. D., white, aged 38, gave a six weeks' history of gradually increasing emesis occurring five to six hours after eating. He complained, also, of gradually increasing constipation and loss of 53 pounds in six weeks. There was no abdominal pain.

The patient was poorly nourished. There was occasional visible peristalsis; no abdominal tenderness or masses.

Laboratory tests showed 1 plus albumin in the urine; a red blood count of 4,980,000; hemoglobin, 98 per cent; white blood count, 8,750 with normal differential count; urea nitrogen, 77 mg. per cent; carbon dioxide, 52; sodium chloride, 233 mg. per cent; sedimentation rate, 7 corrected. Gastric analysis revealed no free hydrochloric acid and was negative for blood. On two occasions the stool was negative for occult blood.

A flat film of the abdomen showed one isolated loop of small bowel dilated with gas. With barium the stomach and duodenal cap appeared normal; the second and third portions of the duodenum and the first 18 to 20 inches of jejunum were markedly dilated. Fluid ahead of the barium made it impossible to determine the actual site of obstruction or the nature of the lesion producing it. After two hours there was very little change in the position of the barium. At the end of thirty hours barium was still present in the dilated jejunum. The x-ray interpretation was obstructing lesion in the upper small bowel, nature not demonstrated.

Operation, July 6, 1940, revealed a napkin-ring constriction of the upper jejunum with dilated, edematous small bowel proximal and normal collapsed bowel distal to the lesion. There were multiple peritoneal transplants in the pelvis. The tumor was excised and side-to-side anastomosis performed.

The pathological report was as follows: Resected jejunum with circular tumor about 5 cm. from the distal end; serosa infiltrated; marked stenosis at site of tumor; proximal jejunum distinctly dilated and wall hypertrophic. Microscopically the lesion is a massively infiltrating adenocarcinoma with some mucoid secretion, involving all layers.

The postoperative course was uneventful and the patient was discharged to the care of his private physician July 21, 1940.

DISCUSSION

Both of the above cases were referred to us with a diagnosis of pyloric obstruction. In neither case did the preliminary plain film give us sufficient information to make a diagnosis of bowel obstruction. With barium marked dilatation of the upper small bowel was found in each case, with a normal stomach and duodenal cap. In the first case the obstruction was not complete and we were able to visualize the lesion and give an accurate roentgen diagnosis. In the second the obstruction was almost complete and we

could not visualize the lesion because of the contents ahead of the barium.

CONCLUSION

Two cases of carcinoma of the upper jejunum with symptoms simulating pyloric obstruction are recorded. In one case the actual lesion was demonstrated roentgenologically.

Buffalo General Hospital, Buffalo, N. Y.

REFERENCES

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ELWARD, JOSEPH F.: Roentgen Diagnosis of Pathological Processes of the Small Bowel. Am. J. Roentgenol. **39:** 289–296, 1937.

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EDITORIAL

Howard P. Doub, M.D., Editor

John D. Camp, M.D., Associate Editor

Responsibility in Radiotherapy

Sometime since, a letter appeared in the *British Medical Journal* from a well known consulting surgeon to the London Hospital concerning his own history. He had an epithelioma of the left tonsillar lingual fold and was treated with x-ray by a well known American radiologist, a total of 3,540 r units being given in fourteen exposures, or about 250 r per treatment. This was supplemented by the insertion of ten radium seeds in the tonsillar pillar and fifteen seeds in the left side of the neck. The radiation produced a first-degree erythema and the tumor disappeared temporarily. The patient's point in making the report was that he suffered severe pain for eight months and even after that time was very uncomfortable.

This letter set in motion a long correspondence in the same journal, some of the writers discoursing on the intense suffering which follows the application of heavy therapeutic doses of radiation; others denying unpleasant results if the treatments are properly administered. Some of those writing were physicians who had been treated; some were radiologists who protested that the radiation was given too rapidly; one, the well known surgeon of the Cancer Hospital in London, Mr. Cecil Rowntree, took a conservative position, and pointed out that a certain amount of pain follows radiation as it follows surgery. Finally, Sir Leonard Hill, the head of an institute for physical therapy, suggested that it would be for the good of mankind if the radium which is in possession of the British Government and has been concealed underground to avoid destruction by bombing were left and never again brought to light. This letter was widely publicized by the press in this country. The whole discussion was closed by the death of the original correspondent from his carcinoma of the tonsillar fold.

There is a good deal of practical interest in such correspondence. It reveals first the fact that there is a great divergence of opinion as to the technical methods of handling radiation. It also calls attention to the fact that the current method of x-ray therapy with a fairly rapid rate of administration, with or without supplementary radium applications, may give rise to prolonged neuralgic disturbances over a long period, and it raises the question of the proper selection of patients for surgery or radiation. In addition it shows the necessity for frank discussion with the patient who is to be treated by radiation, of the possibilities of prolonged discomfort.

The chief significance of this discussion is in connection with tumors of the oropharyngeal region, in which severe discomfort is much more likely to occur than, for example, after treatment of carcinoma of the cervix. In this latter condition, the technic of treatment has now become generally standardized, owing largely to the fundamental work of the Radiumhemmet in Stockholm, the Curie Institute in Paris, and the Memorial Hospital in New York. The risk of treatment here, apart from fistulae, is chiefly infective thrombosis of the pelvic vessels; pain subsequent to the application of radium is rarely severe enough to cause great discomfort.

Nevertheless, even in the treatment of such favorable sites, a certain amount of frankness on the part of the radiotherapist is desirable, to save just the type of criticism which has arisen in England over the case described above. The public is fully informed about surgical methods and re-

sults, as exemplified by the fact that no one would sue because of an abdominal scar but suits for a severe erythema are all too frequent.

The pain following surgical operations is of brief duration and can be controlled by sedatives, and the patient is usually well in a few weeks. The question is whether radiation does not cause more suffering than surgery, and in many cases, when summed up, it certainly does. The difficulties in treating oropharyngeal and tonsillar tumors are enhanced by the possibility of dental infections and of radiation necrosis of the inferior maxilla. On the other hand, it is perfectly true that a certain number of carcinomas of the base of the tongue, tonsil, and upper pharynx can be cured by external irradiation with x-ray given at a slow rate over a period of a month or six weeks, and possibly supplemented by the coincident insertion of moderate amounts of radium, with very little pain afterward if the applications are properly made. There is no question of the advantage of supplementary radium in small doses after x-ray administration is well under way. The bad results are chiefly due to overdosage.

It must, however, be frankly acknowledged that only a moderate number of these tumors, including those of the larynx, can be cured by radiation, and the attitude still is that if the lesion does not disappear, more radiation must be given, even though Coutard has pointed out from his long experience that there is no useful purpose in attempting to exceed a dose of 8,000 r units in the tumor. Further developments along this line must be in the application of higher voltages. It has been repeatedly pointed out that radiation at 400 to 600 kv. is much less damaging to the skin and much less likely to be followed by severe late ulcerations than that given at 200 kv. The engineering problems in the production of 600 kv. x-rays are approaching solution.

It is perfectly possible, using 600 kv., to give 8,000 r units into the base of the tongue or tonsil, provided the rate does not exceed 5 r per minute and the treatment is extended for a month to six weeks, without causing a skin erythema, and with such radiation the late neuralgic pains are apt to be less. In a certain number of patients, especially those of highly nervous disposition, such pains may continue for several years, due probably to pressure on terminal nerve filaments as a result of the sclerosing effects of the radiation which diminishes the blood supply to the tissues by its action on the terminal arterioles.

It is the responsibility of the radiotherapist to warn his patient that a certain amount of discomfort must be expected, and secondly, if he is to irradiate tumors in the cervical region, to provide himself with apparatus which will operate at from 400 to 600 kv. Only thus can he reduce the superficial damage which is inevitable at 200 kv. owing to the 35 per cent of backscatter on the skin, which, when added to the 100 per cent due to the impinging beam on the surface, creates a situation in which only the greatest care in the selection of portals and spacing of radiation can avoid serious injury to the patient and possible death from inhalation pneumonia, thus utterly defeating the purpose of therapy.

FRANCIS CARTER WOOD, M.D.

RADIOLOGICAL SOCIETY OF NORTH AMERICA

REFRESHER COURSES

POST-GRADUATE INSTRUCTION

The Executive Committee announces that the Fourth Annual Refresher Series will be presented at the time of the Annual Meeting at the Fairmont Hotel, San Francisco, Nov. 30–Dec. 1, 1941.

The program has been so arranged that the courses of post-graduate instruction will be given between the hours of 2 and 5 P.M. and 7 and 9 P.M., Sunday, Nov. 30, and from 8 to 10 A.M. daily thereafter during the entire meeting. Nothing else will be scheduled during these hours and the courses have been so arranged that those interested in a particular subject may enroll in a related series.

The courses will be held on the main and terrace floors of the Fairmont Hotel. Admission will be by ticket only. Reservations for enrollment will be made in the order in which they are received. Those who are not members of the Radiological Society of North America will be charged a fee of Two Dollars ($2.00) for a single course or a maximum charge of Five Dollars ($5.00) for the series.

Read the description of the courses, noting particularly the days upon which they are offered; study the diagram of the Plan of Presentation and select carefully your choice for each day, as the number attending each course will be limited. If the directions listed on the Plan of Presentation are followed carefully, errors in enrollment will be avoided.

If the Refresher Courses are not filled by the time of the meeting, tickets will be available at the registration desk, on Sunday, Nov. 30, and thereafter during the meeting.

Course No. 1: Sunday, 2–5 P.M.

EDWARD LEEF, M.D., HUGH ROSE, M.D., EMILE HOLMAN, M.D., and ARTHUR BLOOMFIELD, M.D.

Stanford University School of Medicine
San Francisco, California

Diseases of the Stomach and Duodenum

ARTHUR L. BLOOMFIELD, M.D.

1. Medical aspects of particular interest to the radiologist. Mechanism of the stomach and duodenal symptoms in relation to gastric secretion and motility.
   (*a*) Syndrome of indigestion.
   (*b*) Mechanism of indigestion (motor disturbances).
   (*c*) Gastric secretion and its significance.

EDWARD LEEF, M.D.

2. Radiological examination of the stomach and duodenum. Radiological changes produced by diseases affecting the stomach, cap, and duodenal loop.

HUGH ROSE, M.D.

3. Gastroscopy, particularly as it concerns the radiologist.
   (*a*) Differential diagnosis of gastric lesions.
   (*b*) Correlation between gastroscopic and radiologic findings.

EMILE HOLMAN, M.D.

4. Surgical aspects of particular interest to the radiologist.
   (*a*) Radiologic findings of importance in determining the type of operation.
   (*b*) Lack of correlation between radiologic findings and operability.
   (*c*) Surgical procedures available under differing circumstances.

Course No. 2: Sunday, 2–5 P.M.

W. EDWARD CHAMBERLAIN, M.D.

Temple University
Philadelphia, Pennsylvania

Roentgen Analysis of Fractures

1. General Considerations: The responsibilities of the roentgenologist in the fracture field; the determination of position, including rotary displacements that may be very important yet frequently overlooked; the causes or cause of non-union; safety considerations; medico-legal aspects; records.
2. Apparatus: Biplane and multiplane fluoroscopes, with motion picture demonstration and exhibition of model; safety considerations.
3. Illustrative cases (from the fracture service of John Royal Moore, M.D., Professor of Orthopedic Surgery, Temple University Medical School): Part-by-part review of fractures of hip, thigh, pelvis, spine, etc., from the point of view of their analysis by roentgen methods and avoidance of pitfalls.

Course No. 3: Sunday, 2–5 P.M.

OTTO GLASSER, PH.D., PAUL KIRKPATRICK, PH.D., GIOACCHINO FAILLA, D.SC.

Physics of Radiology

OTTO GLASSER, Ph.D., Cleveland Clinic, Cleveland, Ohio.

1. History of radiology and atomic physics.

PAUL KIRKPATRICK, Ph.D., Stanford University, San Francisco.

2. Physical properties of x-rays.

GIOACCHINO FAILLA, D.Sc., Memorial Hospital, New York.

3. Action of x-rays and gamma rays on living tissues. A brief review of the subject. Action of radiation on isolated cells and cells in a living tissue. Direct and indirect action. Influence of the medium from the physical and biological points of view. Influence of wavelength and dosage rate.

Course No. 4: Sunday, 2–5 P.M.

Radiation Therapy: Panel Discussion

WILLIAM E. COSTOLOW, M.D.,
Los Angeles, California, Presiding

Skin: **EDWIN A. MERRITT, M.D., Washington, D. C.; JOHN T. MURPHY, M.D., Toledo, Ohio; HENRY J. ULLMANN, M.D., Santa Barbara, Calif.; JOHN W. BUDD, M.D., Los Angeles, Calif. (by invitation).**

Breast: **ERNST A. POHLE, M.D., Madison, Wis.; FREDERICK W. O'BRIEN, M.D., Boston, Mass.; ORVILLE N. MELAND, M.D., Los Angeles, Calif.; ALSON R. KILGORE, M.D., San Francisco, Calif. (by invitation).**

Each participant in this course will make a ten-minute presentation of his subject followed by questions propounded by the chairman in an attempt to bring out practical points from the surgeon, pathologist, and radiologist. The Chairman will welcome questions from the audience, which will be answered by various men on the panel including our distinguished guest speakers. Those registered in this course are urged to come prepared to take part in the discussion. The three-hour period will be equally divided between the presentation of the problems of skin and breast cancer.

Course No. 5: Sunday, 7–9 P.M.

FRED JENNER HODGES, M.D.

University of Michigan
Ann Arbor, Michigan

Acute Inflammatory Diseases of the Lung

Presentation of a "Refresher Course" dealing with this subject necessitates the consideration of a much wider range of material than the title implies. The situations from which acute inflammatory lesions must be differentiated are numerous, diversified, and often confusingly misleading. In the true sense, this will be a "Refresher Course," designed to provide a sound and comprehensive review of the principles upon which depends the roentgenologic diagnosis of these conditions. No attempt will be made to introduce innovations of technic or interpretation.

Since diagnostic accuracy is closely correlated with technical perfection, the various procedures involved in the roentgenologic approach to chest diagnosis are briefly reviewed.

Emphasis is placed upon the fact that roentgenograms, and the fluoroscopic screen when used, must be carefully and systematically searched for all bits of evidence which may be serviceable in recognizing the existence and the nature of pulmonary disease. Good habits of film interpretation are described. The extent to which multiple examinations may be valuable or even indispensable in gathering useful evidence is discussed and illustrated.

The various acute inflammatory diseases which may involve pulmonary tissues are enumerated, discussed, and illustrated. Difficulties which one may expect to encounter in differential diagnosis are presented. The proper use of other diagnostic aids in conjunction with roentgenologic methods is discussed.

Course No. 6: Sunday, 7–9 P.M.

SHERWOOD MOORE, M.D., and WENDELL G. SCOTT, M.D.

Washington University School of Medicine
St. Louis, Missouri

Use of Body Section Radiography in the Daily Work of the X-ray Department

The purpose of this course is to point out the indications for the use of body section radiography in the examination of patients coming to a large x-ray department for routine diagnostic examination. The method of choosing the case for body section radiography will be discussed, as well as the way in which the desired levels to be radiographed are selected. A series of slides will be used to demonstrate the value of sectional films in the diagnosis of diseases of the chest, of mediastinal tumors and aortic aneurysms. Other slides will show sectional films of the occipito-atlanto articulation, the upper cervical vertebrae, the temporo-mandibular joints, the condyles of the mandible, and the dorsal vertebrae. The posterior ethmoid cells and the sphenoid sinus also lend themselves to sectional radiography.

The basic principles of body section radiography will be briefly discussed without going into the technical details of the machines that are used for this work.

Course No. 7: Sunday, 7–9 P.M.

Radiation Therapy: Panel Discussion

EDWIN C. ERNST, M.D.
St. Louis, Missouri, Presiding

Intra-Oral: **LEO M. LEVI, M.D., Pasadena, California; FREDERICK H. RODENBAUGH, M.D., San Francisco, California; OTTO H. PFLUEGER, M.D., San Francisco (by invitation).**

Uterus: ROBERT E. FRICKE, M.D., Rochester, Minnesota; HAROLD W. JACOX, M.D., Pittsburgh, Pennsylvania; LUDWIG A. EMGE, M.D., San Francisco (by invitation).

This panel discussion on therapy will be presented in a manner similar to Course No. 4. The guest speakers who are taking part in this refresher course, by invitation, are outstanding men in their special fields and the Chairman urges the enrollees to bring their problems to this panel, where they may be discussed. The first hour will be alloted to intra-oral and the second hour to uterine cancer.

Course No. 8: Monday, 8–10 A.M.

F. E. TEMPLETON, M.D.

Associate Professor of Roentgenology
University of Chicago

Technic in Diagnosis of Gastric and Duodenal Lesions by the Mucosal Relief Method

The use of the filming-fluoroscope and the method of examination of the stomach and duodenum with mucosal relief and compression technics will be discussed. The discussion will include: a description of the equipment and media; the principles underlying the formation of shadows; the relationship of fluoroscopy to films, a routine method of examination; the use of compression; the indications for making films. Also included will be a discussion of special procedures, as the examination of the infant's stomach in congenital pyloric stenosis; the examination of the high, posteriorly placed duodenum in obese patients; a method for obtaining significant views of the pyloric end of the stomach in cases of pyloric obstruction with retention and in debilitated patients too ill to stand for the examination. Lantern slides will be used to illustrate the appearances of the stomach and duodenum as each point is discussed.

Course No. 9: Monday, 8–10 A.M.

D. A. RHINEHART, M.D.

Professor of Roentgenology and Applied Anatomy,
University of Arkansas
Little Rock, Arkansas

Fundamentals in the Interpretation of Roentgenograms of Lungs and Pleura

All diseases that occur within the lungs and pleura are made up of gross pathological processes either singly or in various combinations. If one makes a list of the gross pathological changes that may occur within the lungs and pleura, such as proliferative or granulomatous lesions, exudation and transudation, fibrosis, cavitation, changes in the air content, etc., that list will not be particularly long nor imposing.

These processes within the lungs cause shadows on roentgenograms that are more or less characteristic. The interpretation of films of the lungs may be simplified if one can correlate pathological processes and the kinds of shadows they cause. In this course an attempt will be made to list these pathological processes and demonstrate the types of shadow they produce on films of the thorax.

Course No. 10: Monday, 8–10 A.M.

KENNETH D. A. ALLEN, M.D.

Denver, Colorado

Roentgenologic Depiction of Intracranial Anatomy and Certain Pathologic Conditions

By means of lantern slide demonstration a comparison will be made between the normal anatomical pictures of the brain and spinal fluid pathways and the roentgenogram. Departures from normal will be studied after a presentation of normal findings.

Two images will be presented at the same time, photographs of brain and spinal fluid pathway diagrams and ventriculographic and encephalographic roentgenograms.

Course No. 11: Monday, 8–10 A.M.

LOWELL S. GOIN, M.D.

Los Angeles, California

Roentgen Differentiation of Bone Infections

1. The anatomy and blood supply of bones with particular reference to the end arteries and their relationship to the involvement of the epiphyseal plate.
2. The growth of bone.
3. The anatomy of the epiphyseal plate.
4. The effects of nearby infection which does not damage the plate and that which does damage the plate.
5. The importance of drainage.
6. The diagnosis of osteomyelitis.
7. The differential diagnosis of osteomyelitis, tuberculosis, and granulomata.
8. The differential diagnosis of osteomyelitis and neoplastic disease.
9. Complications including invasion of the joints, soft tissue infections, septicemia and metastatic abscesses.
10. Pathological fracture and the superimposition of epithelioma on a chronic infectious ulcerative lesion.

Course No. 12: Monday, 8–10 A.M.

LEWIS G. ALLEN, M.D.

Kansas City, Kansas

Radiation Therapy of the Breast

The course, "Radiation Therapy of the Breast," will consist of a review of the present status of our

Plan of Presentation

SUNDAY 2–5 P.M.	MONDAY 8–10 A.M.	TUESDAY 8–10 A.M.
1. **Diseases of the Stomach and Duodenum** Edward Leef, M.D. Hugh Rose, M.D. Emile Holman, M.D. Arthur Bloomfield, M.D.	8. **Technic in Diagnosis of Gastric and Duodenal Lesions by the Mucosal Relief Method** F. E. Templeton, M.D.	15. **The Roentgen Investigation of the Esophagus** E. R. Witwer, M.D.
2. **Roentgen Analysis of Fractures** W. Edward Chamberlain, M.D.	9. **Fundamentals in the Interpretation of Roentgenograms of the Lungs and Pleura** D. A. Rhinehart, M.D.	16. **Cardiovascular Roentgenology** Earl E. Barth, M.D.
3. **A. History of Radiology and Atomic Physics** Otto Glasser, Ph.D. **B. Physical Properties of X-rays** Paul Kirkpatrick, Ph.D. **C. Action of X-rays and Gamma Rays on Living Tissues** Gioacchino Failla, D.Sc.	10. **Review of the Roentgenological Depiction of Intracranial Anatomy and Certain Pathological Conditions** Kenneth D. A. Allen, M.D.	17. **The Roentgenologic Diagnosis of Intracranial Disease** John D. Camp, M.D.
4. **Radiation Therapy: Panel Discussion** William E. Costolow, M.D., Presiding **Skin** E. A. Merritt, M.D. J. T. Murphy, M.D. H. J. Ullmann, M.D. J. W. Budd, M.D. **Breast** E. A. Pohle, M.D. A. R. Kilgore, M.D. F. W. O'Brien, M.D. O. M. Meland, M.D.	11. **Roentgen Differentiation of Bone Infections** Lowell S. Goin, M.D.	18. **Differential Diagnosis of Bone Tumors** B. H. Nichols, M.D.
7–9 P.M.	12. **Radiation Therapy of the Breast** Lewis G. Allen, M.D.	19. **X-ray Therapy in Superficial Carcinoma** John T. Murphy, M.D.
5. **Acute Inflammatory Diseases of the Lung** Fred Jenner Hodges, M.D.		
6. **Use of Body Section Radiography in the Daily Work of the X-ray Department** Sherwood Moore, M.D., and Wendell G. Scott, M.D.	13. **Radiation Therapy of Carcinoma of the Cervix** Harold W. Jacox, M.D.	20. **Irradiation Therapy of Carcinoma of Uterine Fundus** Robert E. Fricke, M.D.
7. **Radiation Therapy: Panel Discussion** Edwin C. Ernst, M.D., Presiding **Intra-oral** L. M. Levi, M.D. O. H. Pflueger, M.D. F. H. Rodenbaugh, M.D. **Uterus** R. E. Fricke, M.D. L. A. Emge, M.D. H. W. Jacox, M.D.	14. **A. Production of X-rays** R. R. Newell, M.D. **B. Natural and Induced Radioactivity and the Nature of Alpha, Beta, Gamma and Neutron Rays** Paul Aebersold, Ph.D.	21. **A. Protection of Physicians, Patients and Personnel against the Harmful Effects of Radiation** K. W. Stenstrom, Ph.D. **B. Losing Radium and Finding It Again** Robert Taft, M.D.

Plan of Presentation

WEDNESDAY 8–10 A.M.	THURSDAY 8–10 A.M.	FRIDAY 8–10 A.M.
22. **The Gastro-Intestinal Tract in Infants and Young Children** Samuel G. Henderson, M.D.	29. **Radiology of the Small Intestines** Kenneth S. Davis, M.D.	35. **Radiological Diagnosis of Lesions of the Colon** Lester W. Baird, M.D.
23. **Diseases of the Mediastinum and Associated Conditions** Lester W. Paul, M.D.	30. **Pulmonary Tuberculosis** C. C. Birkelo, M.D.	36. **Coccidioidal Granuloma** Ray A. Carter, M.D.
24. **Contrast Myelography** Joseph C. Bell, M.D.	31. **Radiography of the Cervical Region** Charles S. Capp, M.D.	37. **A Discussion of Anomalies and Fractures of the Spine Including Methods of Examination** Wilbur Bailey, M.D.
25. **Radiological Aspects of the Arthritides** L. H. Garland, M.D.	32. **The Roentgenology of the Urinary Tract** Eugene P. Pendergrass, M.D. George W. Chamberlain, M.D., B.S., Sc.D.(Med.) P. Boland Hughes, A.B., M.D.	38. **The Roentgenology of the Urinary Tract** Eugene P. Pendergrass, M.D. George W. Chamberlain, M.D., B.S., Sc.D.(Med.) P. Boland Hughes, A.B., M.D.
26. **Leiomyoma of the Uterus** Zoe Allison Johnston, M.D.	33. **The Fundamental Principles of Protracted Fractional Radiation** H. Dabney Kerr, M.D.	39. **Reaction of the Skin to X-rays** J. M. Robinson, M.D.
27. **Practical Concepts of Diagnosis, Treatment and Complications of Carcinoma of the Cervix** Edwin A. Merritt, M.D.	34. **Diagnosis and Treatment of Cancer of the Skin and Lip** Henry J. Ullmann, M.D.	40. **Lymphoblastoma (Hodgkin's Disease, Lymphosarcoma and Leukemia)** A. U. Desjardins, M.D.
28. **Measurement, Calculations and Recording of Quality and Quantity of X-ray Dosage** Edith H. Quimby, Sc.D.		

knowledge of the problems as clinically presented. The pathologic classifications and the clinical factors which modify them will be presented and discussed.

The theoretical origin and spread of cancer of the breast will be discussed in detail. The prognostic significance of age, pregnancy, lactation, menstruation, and disease will be considered.

The value of irradiation will be shown by analysis of case reports taken from recent literature. The plan of radiation management will be discussed and technics summarized. A definition of preoperative and postoperative combinations will be offered. Radium therapy by surface, interstitial, and pack applications will be discussed briefly. Radiation therapy as an independent form of treatment will be evaluated. Complications and sequelae of radiation therapy will be defined. Finally a procedure for application of roentgen irradiation, such as the mapping of ports, the choice of technic of application, dosage computation and spacing, in illustrative clinical stages of cancer of the breast, will be offered.

Course No. 13: Monday, 8–10 A.M.

HAROLD W. JACOX, M.D.

The Western Pennsylvania Hospital
Pittsburgh, Pa.

Radiation Therapy of Carcinoma of the Cervix

This course will deal largely with practical clinical problems of the therapeutic radiologist. Both roentgen and radium therapy will be considered.

The technic which the author has found most satisfactory will be described.

Those attending the course are invited to bring difficult types of cases or complications for presentation and informal discussion. Only proved case reports should be submitted.

Course No. 14: Monday, 8–10 A.M.

R. R. NEWELL, M.D., and PAUL AEBERSOLD, Ph.D.

Physics of Radiology

R. R. NEWELL, M.D., Stanford University Hospital, San Francisco.

1. Production of x-rays: Efficiency of an x-ray tube, its structure, with essential parts. Cooling the target. Tube life. Round focus, line focus and rotating anode tube. The engineering and economics of high-voltage supply for a tube. Constant potential, self rectifying, mechanical and valve rectification, three phase. Timers. Therapy machines including supervoltage.

PAUL AEBERSOLD, PH.D., University of California, Berkeley, California.

2. Natural and induced radioactivity and the nature of alpha, beta, gamma, and neutron rays.

Course No. 15: Tuesday, 8–10 A.M.

E. R. WITWER, M.D.

Detroit, Michigan

Roentgen Investigation of the Esophagus

It is proposed to review very briefly the anatomy and function of the esophagus, and to point out some of the lesions of congenital and acquired origin. Foreign bodies both of negative and positive density will be considered. Lesions of inflammatory and neoplastic origin will be discussed, and the differential diagnosis reviewed. The indications for and value of esophagoscopy in conjunction with roentgen investigation will be presented.

Course No. 16: Tuesday, 8–10 A.M.

EARL E. BARTH, M.D.

Northwestern University Medical School
Chicago, Illinois

Cardiovascular Roentgenology

This course will consist of a film and lantern slide demonstration of the roentgenographic signs in the common diseases of the heart and great vessels, cardiac aneurysm, constrictive pericarditis, and congenital heart disease. The anatomy of the heart and great vessels and their relationship to surrounding structures will be reviewed, with a model as a guide. Brief mention will be made of the use of roentgen kymography in diseases of the heart and aorta. Kymograms will be demonstrated.

Course No. 17: Tuesday, 8–10 A.M.

JOHN D. CAMP, M.D.

Section on Roentgenology, Mayo Clinic
Rochester, Minnesota

Roentgenologic Diagnosis of Intracranial Disease

The x-ray evidence of intracranial disease that is revealed in roentgenograms without the use of additional procedures such as encephalography and ventriculography will be discussed.

1. Various forms of calcification occurring in intracranial lesions.
2. Changes in the calvarium.
   (*a*) Generalized changes due to abnormalities of development as a result of intracranial pathology.
   (*b*) Changes resulting from increased pressure.
   (*c*) Localized changes in the calvarium contiguous to the site of lesions such as destruction, proliferation, or both.
3. Changes in the sella turcica.
4. Pineal calcification and displacement of the pineal shadow.

REFRESHER SERIES

THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

November 30—December 5, 1941

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Fill out, also, the enrollment diagram on the reverse side of this page

REFRESHER SERIES

INSTRUCTIONS FOR ENROLLMENT

Read the accompanying description of the courses and study the plan of presentation. It is important that you register early; the number admitted to each course will be limited by the seating capacity of the room. Reservations will be made in the order of the receipt of request.

Non-members will be charged $2.00 for each refresher course up to a maximum of $5.00 for the entire series payable at the time of application to the Radiological Society of North America. Non-member fees should accompany the request for reservations.

PLEASE INDICATE YOUR CHOICE

	COURSE NUMBER	LECTURER
SUNDAY 2–5 P.M.		
SUNDAY 7–9 P.M.		
MONDAY 8–10 A.M.		
TUESDAY 8–10 A.M.		
WEDNESDAY 8–10 A.M.		
THURSDAY 8–10 A.M.		
FRIDAY 8–10 A.M.		

5. Vascular changes in the calvarium.

It will be emphasized in this course that the position of many intracranial lesions may be determined by careful examination of plain roentgenograms without the use of additional diagnostic procedures. Tumors of the scalp and skull simulating intracranial disease will also be discussed.

Course No. 18: Tuesday, 8–10 A.M.

B. H. NICHOLS, M.D.

Cleveland Clinic, Cleveland, Ohio

Differential Diagnosis of Bone Tumors

This course will consist of a classification of bone tumors with a description of the characteristics of each type as observed from the roentgenological and clinical standpoint. The various types of tumors will be arranged in groups with their special characteristics, such as the point of origin, osteolytic character or sclerosing tendency, and whether or not they invade the surrounding tissue. In this primary survey, the differential diagnosis will be considered, and illustrated, between bone tumors and infections of bone, both of the specific types such as tuberculosis and syphilis, and osteomyelitis in general. Consideration will be given traumatic lesions of bone which may simulate a tumor; also bone changes due to systemic disease and lesions of bone of unknown etiology.

By careful analysis and a process of elimination, a given case may be brought to a question of three or four types of tumor. When this stage in the examination is reached, a consideration is undertaken of the clinical history, the physical examination, the laboratory findings, and the probabilities in each of the suspected tumors. In applying this law of probability, there are about twenty-five points of importance for consideration, as, for example, the age of the patient, the duration of the disease, the presence or absence of pain, and the location of the lesion. After this group of probabilities has been completely canvassed, a summation will show the greatest number of these probabilities belonging to one of the suspected tumors. This, then, will most likely be the correct diagnosis.

Course No. 19: Tuesday, 8–10 A.M.

JOHN T. MURPHY, M.D.

Toledo, Ohio

X-ray Therapy in Superficial Carcinoma

A general discussion of the use of x-ray in the treatment of cancer of the skin will be given; 50, 120, and 200 kilovolt therapy will be taken up. Dosages and technic will be considered. The failures and the dangers will also be discussed.

Course No. 20: Tuesday, 8–10 A.M.

ROBERT E. FRICKE, M.D.

Section of Therapeutic Radiology
Mayo Clinic, Rochester, Minnesota

Irradiation Therapy of Carcinoma of the Uterine Fundus

Irradiation treatment of carcinoma of the uterine fundus is an interesting problem and one which is increasing in scope and importance. Planning of treatment depends on the recognition of three categories as follows: (1) preoperative or postoperative irradiation; this type of irradiation is employed when the attack is to be or has been mainly surgical, the patients are in good general physical condition, and the lesions are recognized before much extension has occurred; (2) limited irradiation for extensive inoperable carcinoma with palliation in view; five-year cures are occasionally obtained even in this group; (3) complete irradiation therapy for less extensive tumors in patients who are advanced in age or have serious co-existing disease which makes surgical intervention hazardous. Many five-year cures may be expected from carefully planned treatment.

The technic of treatment will be considered with regard to these three classifications. The symptomatology, diagnosis, complications, and the significance of the microscopic grade and of the stage of the lesion will be discussed. The immediate and final results of irradiation therapy alone will be summarized in a review of cases treated over an eleven-year period at the Mayo Clinic.

Course No. 21: Tuesday, 8–10 A.M.

K. W. STENSTROM, Ph.D., and ROBERT TAFT, M.D.

Physics of Radiology

K. W. STENSTROM, Ph.D., University of Minnesota, Minneapolis, Minnesota.

1. Protection of physicians, patients, and personnel against the harmful effects of radiation.
   (*a*) Protection against radiation from radium and radon. Discussion of protective measures during storage, handling, and transportation of radium and radon and estimation of exposure to personnel. Certain rules which are advisable for treatments in order to obtain satisfactory dose to the patient, to avoid mistakes, and to minimize exposure to physician.
   (*b*) Protection against roentgen radiation during therapy, radiography and fluoroscopy. Proper installation in order to minimize exposure to personnel. Measurements of scattered radiation and of maximum intensity of radiation in control room. Standardization of machines (roentgens in air). Control of output of radiation during treatments by means of

roentgen meters or "iometers." Rules for therapy in order to avoid mistakes. Precaution during radiography and fluoroscopy. Determination of skin exposure of patient. Rules for routine radiographic and fluoroscopic work in order to keep exposure of patients and of personnel within safe limits.

ROBERT TAFT, M.D., Charleston, South Carolina.

2. Losing radium and finding it again. A general consideration of the methods of handling radium element and some of the unnecessary chances which are taken with its loss. The modern type of "radium hound" will be demonstrated and methods of use will be summarized. Time permitting, some of the more humorous recent losses and recoveries will be reported.

Course No. 22: Wednesday, 8–10 A.M.

SAMUEL G. HENDERSON, M.D.

Pittsburgh, Pennsylvania

Gastro-intestinal Tract in Infants and Young Children

1. A brief discussion of the embryology and fetal physiology of the gastro-intestinal tract.
2. The roentgen anatomy and mechanics of the gastro-intestinal tract in the healthy new born infant.
3. Roentgenologic survey of the gastro-intestinal tract in older children without obvious physical defects.
4. Consideration of some of the anomalies and acquired diseases of the alimentary canal in infants and children.

Course No. 23: Wednesday, 8–10 A.M.

LESTER W. PAUL, M.D.

Department of Radiology, University of Wisconsin
Madison, Wisconsin

Diseases of the Mediastinum and Associated Conditions

In this discussion will be included those lesions which produce mass shadows of abnormal character within and adjacent to the mediastinum. The anatomy of the mediastinum and of the tracheobronchial lymph node system will be reviewed, followed by a discussion of the roentgen anatomy of these parts. The roentgen aspects of the diseases affecting the mediastinal and tracheobronchial lymph nodes will be presented in some detail, including acute and chronic non-specific infections, fungus infections, primary tuberculosis, and hyperplastic tuberculous adenitis in adults. In this latter connection the lymph node changes seen in erythema nodosum will be discussed. Also, reference will be made to sarcoid disease and an attempt made to correlate these conditions as far as present knowledge permits. The various primary and secondary tumors involving the lymph nodes will be covered, particularly Hodgkin's disease, lymphosarcoma, and metastases from primary tumors elsewhere. Illustrative cases will be used in which serial roentgenograms show the appearance of the chest before the development of the disease, its course, and in some instances a return to normal. Emphasis will be placed on the recognition of early change as shown by the serial roentgenograms. Other diseases that may produce abnormal shadows in the mediastinum will be discussed, including lesions of the spine, pulmonary artery, aorta, esophagus, acute and chronic mediastinitis, intrathoracic thyroid, enlargement of the thymus, and certain forms of carcinoma of the bronchial tree. Cardiac lesions will not be included except as they must be differentiated from extracardiac abnormalities.

Course No. 24: Wednesday, 8–10 A.M.

JOSEPH C. BELL, M.D.

Louisville, Kentucky

Contrast Myelography

The roentgenologic examination and findings in some patients suffering from low back and sciatic pain will be discussed, with the anatomy of the intervertebral disc, including the nerve supply. The mechanism of extrusion of a portion of the disc into the spinal canal will be taken up, and the importance of the extruded portion of the disc as an etiological factor in some cases of back and sciatic pain will be considered. Myelograms showing various roentgenologic manifestations of such extrusions will be presented. The technic of examination will be illustrated by motion pictures and will be discussed. The surgical findings and postoperative results in cases examined will be reported. The importance of a very close co-ordination of the neurologic examination alone, as the determining factor in localization and as an indication for operation, will be reviewed. Multiple lesions and the differential diagnosis between extrusions of portions of the intervertebral discs and other intraspinal pathology will be considered. The presentation will be fully illustrated by lantern slides.

Course No. 25: Wednesday, 8–10 A.M.

L. H. GARLAND, M.D.

San Francisco, California

Radiological Aspects of the Arthritides

Following a definition of the term "arthritis," there will be presented a general classification of the arthritides and allied arthropathies. The pathological appearance of the more important forms of

arthritis will be discussed. The diagnosis and differential diagnosis of the various types of arthritis will then be outlined, illustrated with roentgenograms, and presented for brief debate. The lack of correlation between the clinical symptoms and roentgenologic findings in common forms of so-called arthritis will be outlined and an attempt will be made to evaluate the usefulness of roentgen examination in the early diagnosis of certain forms of infectious arthritis. The technic and results of the newer forms of roentgen examination of joints by the use of intra- and extra-articular opaque media and mechanical traction will be considered. If time permits, the value and results of roentgen treatment of a few certain specific types of arthritis will be presented and illustrated by lantern slides.

Course No. 26: Wednesday, 8–10 A.M.

ZOE ALLISON JOHNSTON, M.D.

Pittsburgh, Pennsylvania

Leiomyoma of the Uterus

Classification.
Differential diagnosis of benign pelvic lesions.
Methods of treatment:
- Surgery.
- Radium.
- Roentgen therapy.
- Radium and roentgen therapy.

Radiation Therapy.
- Indications.
- Technic.

Sequelae

Course No. 27: Wednesday, 8–10 A.M.

EDWIN A. MERRITT, M.D.

Washington, D. C.

Practical Concepts of Diagnosis, Treatment, and Complications of Carcinoma of the Cervix

1. Diagnosis.
   - (*a*) Inspection with perfect illumination.
   - (*b*) Biopsy should support the clinical examination. Undue trauma is dangerous.
   - (*c*) Anesthesia is usually not indicated. Surgical trauma is too frequent.
   - (*d*) Hemorrhage is controlled by a vaginal gauze pack.
   - (*e*) Infection, which complicates the ulcerating carcinoma, is a factor responsible for as much harm as the malignant process itself.
2. Treatment.
   - (*a*) An amount of radiant energy sufficient to control a superficial cancer of comparable size, extent, and resistance must be delivered and distributed to the center of the pelvis without irreparable injury to the normal structures.
   - (*b*) The period devoted to such treatment should not be prolonged beyond the time when fibrosclerosis produced by radiation therapy has become manifest.
   - (*c*) The surface of irradiated ports and the total daily dose of external irradiation must be regulated to meet the local and constitutional reaction.
   - (*d*) Control of the associated secondary infection of the tumor is essential.
3. Complications.
   Nausea, vomiting, and diarrhea, usually controlled by regulating the size of the skin portal or by reducing the r per treatment.
4. Skin Reactions.
   An intensive, moist, exfoliating epidermis represents the maximum.

Course No. 28: Wednesday, 8–10 A.M.

EDITH H. QUIMBY, Sc.D.

Memorial Hospital, New York City

Physics of Radiology

Measurement, Calculations and Recording of Quality and Quantity of X-ray Dosage

Ionization in air and its application to x-ray measurements. The roentgen. Absorption curves and quality standards. Back-scatter and depth dose measurements in phantoms. The significance of voltage, filter, and distance for actual and relative surface and depth doses. Dosage records (an outline will be furnished).

Course No. 29: Thursday, 8–10 A.M.

KENNETH S. DAVIS, M.D.

Los Angeles, California

Radiology of the Small Intestine

This course is planned to cover the roentgen anatomy of the small intestine together with the changes produced by various pathologies.

Method of examination, normal small intestine, disturbances in physiology, inflammations, and neoplasms will be discussed.

Course No. 30: Thursday, 8–10 A.M.

C. C. BIRKELO, M.D.

Radiologist, Herman Kiefer Hospital and Maybury Sanatorium
Detroit, Michigan

Pulmonary Tuberculosis

This presentation will consist of a lantern slide demonstration of both the common and unusual forms of pulmonary tuberculosis. The primary

tuberculous infection, as it occurs in the child and young adult, will be demonstrated. Reinfection tuberculosis, both the productive and exudative types, will be shown and the commonly accepted methods of treatment will be briefly discussed.

Differential diagnosis will include x-ray demonstration of cases which resemble tuberculosis but have been found to be bronchopneumonia, primary and metastatic tumors of the lungs, bronchiectasis and cystic disease, lung abscess, mitral heart disease, and silicosis. All material presented will consist of proved cases.

Course No. 31: Thursday, 8–10 A.M.

CHARLES S. CAPP, M.D.

Assistant Clinical Professor of Radiology
University of California Medical School
San Francisco, California

Radiography of the Cervical Region

This course will review the embryologic development of the cervical vertebrae; the anatomic anomalies and their clinical significance. The common and unusual roentgen projections, the advantages and disadvantages of each, will be discussed in relation to the individual diagnostic problem.

The roentgen examination of extra-skeletal lesions will be included in this course.

Courses Nos. 32 and 38: Thursday and Friday, 8–10 A.M.

EUGENE P. PENDERGRASS, M.D., GEORGE W. CHAMBERLAIN, M.D., B.S., Sc.D. (Med), and P. BOLAND HUGHES, A.B., M.D.

University of Pennsylvania
Philadelphia, Pennsylvania

Roentgenology of the Urinary Tract

1. Roentgen methods and materials.
   (*a*) Evaluation of types of examination.
   (*b*) Uses and limitation of roentgen procedures.
   (*c*) Dangers of urography.
2. The normal urinary tract.
   (*a*) Physiology.
   (*b*) Anatomy.
   (*c*) Roentgen interpretation.
3. Anomalies and variants.
   (*a*) Embryology of some of the common anomalies.
   (*b*) Rôle of anomalies in development of disease.
   (*c*) Late results of anomalies.
4. Roentgen interpretation of genito-urinary tract disease.
   (*a*) Stones.
   (*b*) Infections.
   (*c*) Tumors.
   (*d*) Cysts.
   (*e*) Miscellaneous.
5. Value of urography in disease primarily outside of the urinary tract.
   (*a*) Aneurysms.
   (*b*) Retroperitoneal tumors and infections.
6. Cystoscopy and urethrography.

Course No. 33: Thursday, 8–10 A.M.

H. DABNEY KERR, M.D.

The State University of Iowa, Department of Radiology
Iowa City, Iowa

Fundamental Principles of Protracted Fractional Radiation

In this course, the general basis for deep therapy will be considered. Quality of the beam, back-scatter, measurement of dose, selection of field, depth dose percentage and calculation of tissue dose will be discussed. In more detail, the discussant's method of treatment of pelvic neoplasms will be taken up, and the advantages and disadvantages of various technics reviewed.

Course No. 34: Thursday, 8–10 A.M.

HENRY J. ULLMANN, M.D.

Santa Barbara, California

Diagnosis and Treatment of Cancer of the Skin and Lip

As those who attend this course are already familiar with the subject, emphasis will be placed on differential diagnosis and details of treatment rather than on general principles.

Movies and stills, largely in color, will be used to illustrate lesions that simulate or suggest cancer but were proved benign, and, conversely, lesions that clinically seemed to be benign but were shown to be cancer when checked by biopsy. The important details found by simple clinical methods, such as visualization and palpation as well as history, that suggest the possibility of cancer strongly enough to require biopsy before treatment is instituted will be stressed.

General principles of treatment will be briefly reviewed, followed by a general round-table discussion of details and results.

Course No. 35: Friday, 8–10 A.M.

LESTER W. BAIRD, M.D.

Scott-White Clinic
Temple, Texas

Radiological Diagnosis of Lesions of the Colon

This course will consist of a short résumé of the preparation and technic used in the roentgenologic examination of the colon by means of contrast media. In addition, the double contrast method of examination will be discussed.

The roentgen diagnosis and differential diagnosis of inflammatory and malignant lesions of the large bowel will be presented.

Some of the common causes of error in the diagnosis of lesions of the colon will be discussed.

Course No. 36: Friday, 8–10 A.M.

RAY A. CARTER, M.D.

Radiologist, Los Angeles County General Hospital
Los Angeles, California

Coccidioidal Granuloma

1. A brief description of the organism, comparing it with other fungi.
2. A brief historical survey of the work done on this disease.
3. A brief description of the pathology and clinical aspects.
4. Demonstration of roentgen manifestations of coccidioidal granuloma, pulmonary, osseous, and miscellaneous, comparing these with similar manifestations of other diseases.
5. The point of view is taken that there are no pathognomonic roentgen signs and that the positive diagnosis rests on identification of the organism. Definite predilections and significant associations of lesions often permit a provisional diagnosis.

Course No. 37: Friday, 8–10 A.M.

WILBUR BAILEY, M.D.

Los Angeles, California

Discussion of Anomalies and Fractures of the Spine, Including Methods of Examination

The technic of examination with special reference to the demonstration of the lumbosacral intervertebral disc space and the value of roentgenograms made in the erect and oblique positions will be considered.

Anomalies which may be mistaken for fractures, spondylolisthesis, and fractures of the vertebral body and its processes will be discussed.

Course No. 38: Friday, 8–10 A.M.

EUGENE P. PENDERGRASS, M.D., GEORGE W. CHAMBERLAIN, M.D,, B.S., Sc.D. (Med), and P. BOLAND HUGHES, A.B., M.D.

University of Pennsylvania
Philadelphia, Pennsylvania

Roentgenology of the Urinary Tract

For description see Courses Nos. 32 and 38, page 372.

Course No. 39: Friday, 8–10 A.M.

J. M. ROBINSON, M.D.

University Hospital
San Francisco, California

Reaction of the Skin to X-rays

This course will discuss the types of skin reactions, the various explanations which have been advanced for them; their relation to the chemical constitution of the skin, energy content of the radiation, quality, spacing, rate of delivery, fractional and total dosage; and the value of the erythema as an indicator of biological effectiveness compared with other biological indicators and with the ionization chamber. This will be illustrated particularly by a comparison of the skin reactions produced by x-rays generated at 200 kv. (HVL 1.05 mm. Cu) and 1,000 kv. (HVL 9.5 mm. Cu).

Course No. 40: Friday, 8–10 A.M.

A. U. DESJARDINS, M.D.

Section on Therapeutic Radiology
The Mayo Clinic, Rochester, Minnesota

Lymphoblastoma (Hodgkin's Disease, Lymphosarcoma and Leukemia)

Lymphoblastoma is much more common than has heretofore been thought. Many cases still go unrecognized for a long time, chiefly because most physicians do not think of lymphoblastoma unless the patient has enlarged cervical, axillary, or inguinal nodes. In many cases the cervical, axillary, or inguinal nodes may not be palpably enlarged or only slightly so, and yet the patient may have a well established or even advanced lymphoblastoma. Another reason why many cases go unrecognized is the great variation in the presenting symptoms, which are often mistaken as indications of other pathological disturbances.

Relative importance of the presenting symptoms: involvement of the mediastinal nodes; involvement of the retroperitoneal nodes; involvement of other nodes; extranodular infiltration; skin manifestations of lymphoblastoma; great variation in the complications which may arise during its course; pathologic considerations; emission of blood; treatment in relation to the anatomic distribution of the disease and of its complications; quantity and quality of roentgen rays applied; variations in radiosensitiveness and reasons therefor; effect of treatment on the blood cells, immediately as well as later; prognostic indications of the condition of the blood; radio-resistance and its meaning; repetition of treatment and factors which should govern it; prognosis and factors governing survival.

Announcements

RADIOLOGICAL SOCIETY OF NORTH AMERICA

ANNUAL MEETING

Once again attention is called to the Twenty-Seventh Annual Meeting of the Radiological Society of North America, to be held in San Francisco, Dec. 1 to Dec. 5, 1941, with headquarters at the Fairmont Hotel.

SCIENTIFIC EXHIBITS COMMITTEE

Dr. E. R. Witwer, Chairman of the Scientific Exhibits Committee, wishes to call to the attention of the members the excellent facilities which are available for exhibits at the Annual Meeting in San Francisco. The room is large and particularly well adapted to this purpose. A program of unusual interest is in preparation and many of the essayists have signified that they will supplement their presentations with exhibits. The Committee hopes to make this an outstanding feature of the Annual Meeting and is devoting much time and effort to that end.

Those who have material to present are urged to communicate as soon as possible with Dr. E. R. Witwer, Harper Hospital, Detroit, Michigan.

TENTATIVE PROGRAM FOR LADIES' ENTERTAINMENT

The following varied and interesting program has been arranged by Mrs. L. Henry Garland and her committee for the entertainment of the ladies attending the Annual Meeting:

Sunday, Nov. 30	
Registration	2:30 P.M.
Monday, Dec. 1	
Registration	10:00 A.M.
Reception and tea	4:00 P.M.
Conducted tour through Chinatown	8:00 P.M.
Tuesday, Dec. 2	
Conducted tour of the city	11:00 A.M.
Luncheon at Lakeside Golf and Country Club	1:00 P.M.
Carman Lecture	8:00 P.M.
Wednesday, Dec. 3	
Private shopping trips (cars available)	10:00 A.M.
Trip across San Francisco Bay to Berkeley and visit to cyclotron	3:00 P.M.
Night club dinner dance	7:30 P.M.
Thursday, Dec. 4	
Drive down Peninsula; lunch at Allied Arts Guild; drive through Stanford University	11:00 A.M.
President's dinner and dance	7:30 P.M.

AMERICAN COLLEGE OF SURGEONS

The thirty-first annual Clinical Congress of the American College of Surgeons will be held in Boston, November 3 to 7, with headquarters at the Statler and Copley-Plaza hotels. The twenty-fourth annual Hospital Standardization Conference sponsored by the College will meet concurrently.

TEXAS RADIOLOGICAL SOCIETY

The following officers have been chosen by the Texas Radiological Society for the ensuing year. President, M. H. Glover, M.D., Wichita Falls; President-Elect, G. D. Carlson, M.D., Dallas; First Vice-President, P. E. Wigby, M.D., Dallas; Second Vice-President, T. B. Bond, M.D., Fort Worth; Secretary-Treasurer, L. W. Baird, M.D., Temple.

The next annual meeting will be in Houston, Texas, on February 7, 1942.

CANADIAN ASSOCIATION OF RADIOLOGISTS

Dr. W. H. McGuffin, a former president of the Radiological Society of North America, was elected president of the Canadian Association of Radiologists at their meeting in June.

In Memoriam

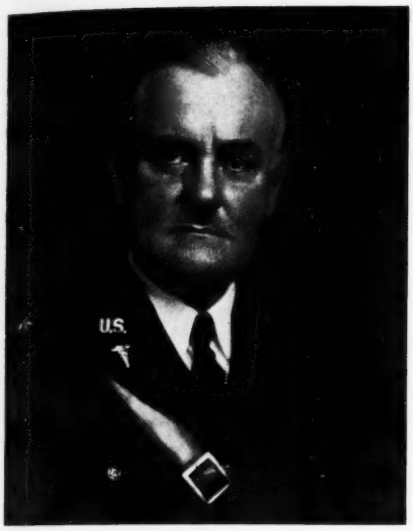
CHARLES A. STAMMEL, M.D.

Lieut. Colonel, Medical Corps, U. S. Army

Charles A. Stammel, Lieutenant Colonel, Medical Corps, U. S. Army, died suddenly of coronary disease, at Fort Lewis, Washington, on May 25, 1941. Funeral services were held at the Arlington National Cemetery on June 2.

Those who have worked closely with Colonel Stammel will remember him as an unassuming, thoroughly co-operative, and genuinely ethical confrere. Many will think of him as a jovial friend—always ready to give others leeway of expression but eager to add humor and pleasantries to an occasion. He was a real gentleman. Radiologists will associate with him descriptions of unusual cases, for which he seemed to possess such an avidity.

Colonel Stammel was born on Feb. 4, 1886, in Cincinnati, Ohio. He received his medical degree from the University of Cincinnati in 1910. In 1917, he joined the Ohio National Guard, being commissioned as a First Lieutenant. He served first at Camp Sheridan, Alabama. From there he was transferred to the Army Medical School, in Wash-



U. S. Army Medical Museum Neg. no. 63243

LIEUT. COLONEL CHARLES A. STAMMEL, MEDICAL CORPS, U. S. A.

ington, D. C., and on Jan. 2, 1918, he was admitted to the regular Army and assigned to duty with the 83rd Division at Camp Sherman, Ohio. He accompanied this organization to France in June 1918, serving with the Divisional Trains and the Office of the Surgeon at Le Mons. After the armistice, he served with the Second Division at Vollander, Germany, and later with Headquarters of the 7th Army Corps at Wittlich, Germany. In May 1919, he was transferred to duty at St. Nazaire, France, and later to Brest. He returned to the United States in December 1919, serving at Fort Sheridan, Illinois, until the fall of 1920, when he was ordered to the Army Medical School in Washington and to the Medical Field Service School, at Carlisle Barracks, Pennsylvania, for the combined basic courses.

Following a short tour of duty at the Army and Navy General Hospital, Hot Springs, Arkansas, he was returned to the Army Medical School for a special course in roentgenology. From that time, his assignments were steadily in connection with this specialty, at Fort Sam Houston, Texas, El Paso, Texas, The Philippine Islands, The General Dispensary, Washington, D. C., Fort Benning, Georgia, and Fort Lewis, Washington. He was promoted to Captain in 1920, to Major in 1929, and to Lieutenant Colonel in 1937.

Colonel Stammel was a member of the Radiological Society of North America and The American Roentgen Ray Society, a diplomate of the American Board of Radiology, an associate fellow of The American College of Radiology, and a member of the American Medical Association and the Association of Military Surgeons.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

DIE WIRBELSÄULENVERLETZUNGEN UND IHRE AUSHEILUNG [Vertebral Injuries and Their Healing. Experimental, Anatomo-pathologic and Clinico-roentgenologic Investigations]. By DR. ALFONS LOB, Navy Staff Physician of the German Reich, with an introduction by DR. G. MAGNUS of Munich. A monograph of 182 pages with 289 illustrations. Published by Georg Thieme, Leipzig, 1941. Price: 28.50 R. M. bound.

ROENTGEN TECHNIQUE. By CLYDE MCNEILL, M.D., Louisville, Kentucky. Second Edition. A volume of 329 pages with 275 figures. Published by Charles C. Thomas, Springfield, Ill., 1941. Price: $5.00.

Book Reviews

RADIOLOGY PHYSICS. An Introductory Course for Medical or Premedical Students and for All Radiologists. By JOHN KELLOCK ROBERTSON, F.R.S.C., Professor of Physics, Queen's University, Kingston, Canada. A volume containing 270 pages with numerous illustrations, diagrams, and tables. Published by D. Van Nostrand Company, Inc., New York City, 1941. Price: $3.50.

This is the revised edition of an earlier publication which had its origin in a series of papers presented by the author in some of the early issues of RADIOLOGY. The original articles and first edition proved popular with radiologists because of the simple and logical manner in which the fundamental facts were presented. The same features characterize the new edition, which has been revised and brought up to date.

The work is not intended to be a comprehensive handbook, but is rather a simple explanation of the principles of the physics of radiology, intended primarily for students and physicians beginning their radiological training. The author presupposes an elementary knowledge of electricity. From this point he takes the reader through all the important stages of the theory and development of radiologic apparatus, the properties of radiation, and its application and uses. Throughout, the mathematical concepts of the subject have purposely been simplified. Among the most interesting and stimulating features of the book are the 132 quiz questions in the appendix, all of which are covered by the text, but most of which the average radiologist could not answer offhand.

Because of the simplified manner in which the subject is presented, the well trained radiologist and physicist may find certain minor faults in the text. The volume fulfills its purpose, however, in a most excellent fashion and as a stepping stone to the more comprehensive and complicated texts pertaining to the physics of radiology it can be heartily recommended.

THE BIOLOGIC FUNDAMENTALS OF RADIATION THERAPY: A TEXTBOOK. By FRIEDRICH ELLINGER, M.D., Research Fellow, Radiotherapy Department, Montefiore Hospital, New York City, formerly Privatdozent in Radiology at the University of Berlin. Translated by REUBEN GROSS, M.D. Preface by MAURICE LENZ, M.D., New York. Pages 360, illustrations 79. Published by Elsevier Publishing Company, Inc., New York; distributed by Nordeman Publishing Company, Inc. Price: $5.00.

This is the American edition of a book published in Berlin in 1935 (reviewed in Radiology **27:** 753, 1936). It is divided into five parts: the first part being devoted to the action of roentgen rays and radium rays on different tissues, the second part to the action of the corpuscular rays, the third part to the action of ultraviolet rays, the fourth part to the action of visible light, and the fifth part to general radiation biology and therapy.

As a concise textbook for students, general practitioners, and radiologists this is perhaps as useful a book as anything now available. However, for those who really want to understand as much as anyone can about the action especially of roentgen rays and radium on different organs and tissues, this text is perhaps too brief to be wholly satisfactory. The extensive bibliography will be valuable to many. In no sense of the word can this be regarded as a reference work. It does not purport to be a treatise, but only a textbook.

ARQUIVO DE PATOLOGIA: Orgao de Instituto Portugues para o estudio do cancro [Archives of Pathology: Official Organ of the Portuguese Institute for the Study of Cancer]. Edited by F. GENTIL and M. ATHIAS. Volumes 11 and 12, 1939, and Volume 12, Nos. 1 and 2, 1940. Published by Palhava, Lisbon.

Like previous issues of this journal, these numbers also consist of well presented, rather lengthy special articles on various oncologic subjects. There are, for example, two articles by Askanazy, one on the etiology, the morphology, and the physiology of malignant tumors and the other on neoplastic metastases; an article by Schinz on the treatment of sarcoma; three by Negus on tumors of the air passages; one, of 228 pages, by Morais on carcinoma of the rectum; one by Gentil on hospitals in Lisbon and Porto, with full details and complete plans; an article of 98 pages by Morais on giant-cell tumors. Though the articles are in Portuguese, they are accompanied by abstracts in English, French, and German.

Golden Gate Bridge, San Francisco

The Employment of Physicians by Hospitals: Some Legal Aspects

(*Continued from August issue*)

Fiscal Arrangements. To illustrate the different relationships created under different types of agreements between physicians and hospitals, specific mention may be made of the various types of fiscal arrangements existing between radiologists and hospitals.[18] We are interested in determining when a physician is an employee and when he is an independent contractor.

Among radiologists practising their specialty in hospitals in this country, 36.4 per cent are on a straight salary basis.[19] Another 7.3 per cent are paid a salary by the hospital, plus a percentage of gross collections or net profits. The great majority of radiologists serve in hospitals on a commission basis, 47.3 per cent receiving as compensation a percentage of the gross or net income. It is hardly debatable that the hospital is itself practising medicine as principal in those cases where a portion of the *net* income goes to the hospital as profit. About 9 per cent of radiologists practising in hospitals lease the roentgen department, paying the hospital a monthly rental therefor, or performing charity work in lieu of rent.

Thus there are at least three different types of legal relationship created by agreement between hospitals and radiologists: (1) The radiologist may be an employee who receives as compensation for his services a percentage of the gross or net collections, or he may receive a fixed salary or a salary plus percentage. We have seen that if he is an employee, he is an agent or a servant. (2) The hospital and the radiologist may be partners under a joint enterprise agreement providing for a division of profits either on a percentage or a flat sum plus a percentage basis. (3) A relationship of landlord and tenant may be created under which the radiologist leases certain premises and pays to the landlord a fixed rental or a rental measured by a percentage.

Under the law of agency, the physician is a servant of the hospital under the first and the second type of arrangement. The elements of agreement, appointment and acceptance, consideration (salary or commission) and mutuality, all factors in the creation of an agency relation, are present. The master has the power to select and discharge the servant.[20]

It is a generally accepted principle of the law that an employer to whose benefit an act inures is estopped to deny that the actor was his agent. He cannot accept the fruits of the relationship and avoid the vicarious liability which the law fixes upon him.[21]

Whether or not the radiologist is a servant when he rents the space utilized is another question. One may be both a lessee and agent, but where the intent of the parties, as evidenced by the whole contract and surrounding circumstances, was to create a lease, it will be so regarded,[22] and the acts of the tenant will impose no liability on the landlord. It has been repeatedly recognized that whether the relationship is one of agency or of independent contractor is determined by the facts of each particular case.[23]

Tort Liability.—Obviously, the courts have been convinced that employment of physicians by hospitals created an agency in fact when holding hospitals liable for torts of such employed physicians.[24] They have simply applied the familiar maxim of agency—*respondeat superior. Agentes et consentientes pari poena plectentur.*[25] Before going further, we should dispose of one point. The mere fact that a corporation is found liable in tort for the acts

[18] See Manual of Desirable Standards for Hospital Radiological Departments, Chicago, The American College of Radiology, 1939, p. 10. The Council on Medical Education and Hospitals of the American Medical Association requires that a hospital, to meet the essentials for registration, must not operate the department of radiology as a source of profit. (Sec. 5, Par. 3.)

[19] "Economics of the Practice of Radiology," J. A. M. A. **113:** 943–948, Sept. 2, 1939.

[20] 18 R. C. L. 782.

[21] Mayor v. Dean, 115 N. Y. 556, 22 N. E. 261, 5 L. R. A. 540. See Mechem, Floyd R.: Outlines of Agency, Chicago, Callaghan & Co., 1923, Sec. 148.

[22] Oriental Investment Co. v. Barclay, 64 S. W. 80; State v. Page, 40 Am. D. 608; Colcord v. Hall, 3 Heat (Tenn.) 625. 4 L. R. A. (N. S.) 698.

[23] Best Mfg. Co. v. Peoria Creamery Co., 138 N. E. 684, 307 (Ill.) 238.

[24] See 2 C. J. Sec. 1041, and cases cited there.

[25] 5 Coke 80.

of employed physicians does not mean that such employment is legal. A corporation cannot employ an agent to perform any act which is not authorized by its own charter or by the law.[26] A principal can delegate to another no greater power or authority than he, the principal, possesses. Authority can flow only from the principal to the agent, not from the agent to the principal.[27]

Although the contract of employment as between the principal and his agent might be unenforceable because of illegality, it may nevertheless create liability in favor of third persons against the principal.[28] An agency illegal in its inception may be ratified to create liability in the principal.[29] A principal can ratify an illegal agency,[30] and an acceptance of a fee by a physician's employer has been held to constitute ratification, making the employer liable on the physician's contract of guaranty.[31] Likewise, false and fraudulent representations by the physician are imputable to his employer.[32] The fact that the law requires a certain standard of skill does not prevent the relationship of master and servant arising.[33]

The cases in point provide ample authority for the conclusion that an employed physician is the agent of his employer.[34] The New York case of Renouf v. New York Central Railroad is especially interesting. In appealing a decision against the railway company, holding it liable for injuries sustained by a nurse while caring for an employee of the company on the

[26] 7 R. C. L. 621.

[27] LaBelle v. Hennepin, County Bar Assn., 288 N. W. 788, 244 Pac. 1089. (Corporation composed solely of attorneys.)

[28] Mechem, *op. cit.*, Sec. 53.

[29] Ibid, Sec. 123.

[30] 2 C. J. Sec. 56.

[31] Jurkins v. Pratt, 158 N. Y. S., 676, 2 C. J. Sec. 56; Homan v. Redick, 96 Neb. 299, 149 N. W. 782, L. R. A. 1915 C, 601; Bourland v. McKnight, 79 Ark. 427, 96 S. W. 179, 4 L. R. A. (N. S.) 698.

[32] 129 A. L. R. 337.

[33] *Restatement, op. cit.*, Sec. 220.

[34] 21 R. C. L. 395. ("It is generally held that persons and hospitals that treat patients for hire, with the expectation and hope of securing therefrom gain and profit, are liable for negligence and malpractice on the part of physicians or nurses employed by them.")

Stanley v. Schumpert, 117 La. 255, 41 So. 565; Broz v. Omaha Maternity, etc., 96 Neb. 648, 148 N. W. 575; Aderhold v. Bishop, 94 Okla. 203, 221 Pac. 752, 60 A. L. R. 137.

21 R. C. L. 396. ("Clearly a corporation or an individual employing a physician to act as its or his agent is liable for the malpractice of the physician, being held *on the ordinary principles of agency*, as for example, where a department store runs a dental office in connection with and as a part of its business. This would be true, *a fortiori*, where the corporation employing the practitioner was not legally qualified to do business in the state.")

Tompkins v. Pac. Mut. L. Ins. Co. 53 W. Va. 479, 44 S. E. 439, Hannon v. Siegel Cooper Co., 167 N. Y. 244, 60 N. E. 597; Mandeville v. Courtright, 142 Fed. 97.

United Dentists, Inc. v. Bryan (Va.) 164 S. E. 554, (Where a corporation practising dentistry was held

Footnote 34, cont.

liable for the malpractice of a dentist employee. No question was raised or discussion as to whether or not dentist employee was independent contractor.)

Jenkins v. Charleston, etc. (W. Va.) 110 S. E. 560. ("A hospital conducted for private gain is liable to its patient for injuries sustained by him in consequence of incompetence or negligence of a physician treating him at its instance, under a contract binding it to furnish him proper treatment . . . . For two good reasons *the defense of injury by an independent contractor* could not be maintained. The roentgenologist was employed and paid by the defendant to perform work in discharge of its own contract and undertaking to diagnose and treat the injury . . . . .")

Brown v. La Société Française 71 P. 516, 138 Cal. 475. (The court held that where a hospital agreed to receive plaintiff for treatment on payment of $50 for an operation and $3.00 a day for room, and surgeon performing the operation was the surgeon-in-chief of the hospital, who was paid by it by the month, the surgeon was the servant of the hospital, and not an employee of the patient.)

Gosnell v. Southern Ry. Co. (N. C.) 162 S. E. 569. ("In the complaint alleged in the instant case, it is not alleged that Doctor Hilland was an employee of the defendant, Biltmore Hospital, Inc., or treated the plaintiff as the agent of said defendant. In the absence of such allegations, the facts stated in the complaint are not sufficient to constitute a cause of action against the defendant, Biltmore Hospital, Inc.")

See also Penland v. French Broad Hospital (N. C.) 154 S. E. 406, to the same effect.

Gilstrap v. Osteopathic Sanatorium Co., 24 S. W. (2nd) 249. ("Appellant insists that there was no evidence upon which to submit to the jury the question of defendant's liability for the acts of Doctor McReynolds in treating plaintiff's husband; that he was not defendant's agent but was acting in his own behalf. In view of all the facts and circumstances in this case, we are satisfied that appellant's contention cannot be sustained. It is admitted . . . that the defendant corporation owned and operated a large sanitorium for the treatment of human ailments and afflictions, that it maintained a large staff of physicians . . . ; that Doctor McReynolds, in addition to a salary paid by defendant, was given his room and board in said sanitorium and that he lived there, and that he got the same pay for his services whether he treated 1 or 150 patients; that the solemnly declared purpose and object of the corporation, among other things, was to treat all human ailments and afflictions . . . . The only reasonable and proper inference that may be drawn is that the deceased understood and believed that he was entering defendant's sanitorium as its patient to be treated by its physicians and surgeons, and that when he entered the sanitorium as its patient the relation of physician and patient was created between him and the defendant.")

Brandt v. Sweet Clinic (Wash.) 8 P. (2nd) 972. ("It is next contended that the appellant Sweet Clinic, being a corporation, cannot practice surgery; therefore it cannot be held to respond in damages for malpractice by one of its surgeons . . . . The contention is without merit. The Sweet Clinic is a corporation carrying on a medical and surgical business for profit, and is liable for malpractice of the operating surgeons who in the cases at bar were employees of the corporation.")

Richardson v. Carbon Hill Coal Co., 6 Wash. 52, 32

order of its surgeon[35], counsel for the insurance company contended that a nurse, like a physician, is engaged in an independent calling and that neither can become the servant of another. This argument, said the Supreme Court of New York, is fallacious. "Ordinarily the relation of master and servant does not exist between a person engaged in the practice of a profession and a person who engages him for a limited purpose or transaction. There is no reason, however, why that relation cannot be created. Frequently, lawyers, doctors, and other men of skill are employed at regular salaries for definite periods of time. Such a contract of employment creates the relation of master and servant. *Greenberg v. Jerome H. Romick & Co., 230 (N. Y.) 70, 75, 129 N. E. 211.* The relation may be created by contract either express or implied. *Brown v. St. Vincent's Hospital, 229 App. Div. 402, 226 N. Y. S. 317* . . . . Whether or not the relation exists may be tested by the right of the employer to control or direct the work of the employee, the payment of wages, and the right to hire and discharge."

This decision was strengthened by differentiation on appeal to the highest court in *State Industrial Board v. N. Y. Cent. R. R. Co. (N. Y.) 173 N. E. 218.* The railroad company appealed from a decision affirming an award of compensation. Said the court, "A trained nurse called in by a railroad company on a special case is not in the service of, or a servant of, the company, within the meaning of the Workmen's Compensation Act. She is a professional person like a physician, employed to exercise her calling to the best of her ability according to her own direction, subject only to the general directions of the physician in charge." The court said that the rule rests on the fact that one who employs such a nurse to take care of an injured person undertakes, not to treat the employee through the agency of the nurse, but to procure a nurse for the special purpose for which her services are required. Although the nurse engaged for special duty was in a general sense employed by the railroad company, she was not its employee. "She occupied the position of an independent contractor following her own calling, rather than that of one in the service of the employer." There may be a different rule, the court said in its dicta, in the case of a nurse who places her time and service at the call of her employer without regard to special services. Clearly, the court in reaching this decision, differentiated between a factual situation where a professional person is employed at a permanent stipend, and where he was called in for a special service to be rendered a third person.

The cases holding that a physician is not the servant or agent of his employer, but is rather an independent contractor, are decidedly in the minority. "The decisions of which the rationale is that physicians and surgeons are not the servants of their employers are referrable to the conception that they are 'professional men' who are engaged in the understanding that they are to 'exercise their profession to the best of their ability according to their own directions; but in exercising it they are in no way under his (their) orders or bound to obey his (their) direction.' This theory as to the nature of their position necessarily implies that they are independent contractors—a designation which has sometimes been specifically ap-

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Footnote 34, cont.

P. 1012. ("If, on the other hand, the company was conducting a hospital with its own physician for the purpose of deriving profit therefrom, or if it contracted with the appellant to furnish him with the services of a competent physician, and to properly treat him in case of an injury, it would be liable for the negligence or want of skill of its physician in attending him.")

Moulton v. Huckleberry (Ore.) 46 Pac. (2nd) 589. ("A physician who recommends or sends another physician to a patient is not liable for injuries resulting from the latter's want of skill or care unless the recommended physician is in his employment, or is definitely his agent or partner, or unless due care is not exercised in making the recommendation or substitution . . . . It plainly follows that where one physician is in the employment and is definitely the agent of another physician then the employing physician is liable for the negligent treatment or malpractice of his employee.")

Skidmore v. Oklahoma Hospital, 278 Pac. 334. (The Oklahoma Supreme Court, quoting with approval Tulsa Hospital Association v. Juby, Okla. 243, 175 Pac. 519, declared that when patients are accepted for financial gain, the hospital receives them "under the implied obligation that it will exercise ordinary care and attention for their safety. The hospital is liable in damages to the patients for the negligence of nurses and other employees.")

Lincoln Park Coal & Brick Co., v. Industrial Commission *et al.* (Ill.) 148 N. E. 79. ("A corporation must exercise due care in selecting its physician employee.")

Vaughan v. Memorial Hospital, 130 S. E. 481. ("A hospital incorporated and conducted for private gain for the benefit of its stockholders, is liable in damages to its patients for negligence or misconduct of its officers and employees. . . . In its contract it stands upon the same basis as any other contractor, and as to employees and third persons it is subject to the same general rule, *respondeat superior*.")

[35] Matter of Renouf v. N. Y. Cent. R. R. 229 App. Div. 58, 240 N. Y. S. 720. See also Hearns v. Waterbury Hospital, 66 Conn. 98, 33 Atl. 604. (" . . . substantial justice is best served by making a master responsible for the injuries caused by his servant acting in his service, when set to work by him to prosecute his private ends, with the expectation of deriving from that work private benefit.")

plied to them."[36] It should be emphasized here that the fact of control of the servant's acts by the master is not the criterion as to whether an agency relation exists; the right of control is the determining factor.[37]

An interesting statement of the minority view is contained in a Louisiana case[38] in which the Court of Appeals recognized the relationship of master and servant between a hospital and an employed surgeon, but stated that this represents an exception to the doctrine of *respondeat superior*, and quoted with approval from *France, 15 Bandry-Lacantinerie (3rd) 617:* "Thus a master is not responsible for the damages caused by the one who is habitually his employee, when the latter, although still in the exercise of his functions in using the things belonging to his master, acts in the premises under the orders of the third party."

In an Arkansas case[39] it was held that a radiologist employed by a group of physicians was not agent of these physicians. West Virginia, on the contrary, has ruled that a radiologist employed by a hospital is an agent and not an independent contractor.[40]

At this point it should be remarked that there is an essential difference in the circumstances of a case where the physician is an employee of the corporation which collects his fees and not infrequently realizes a sizeable profit therefrom, and of a case where the physician is merely a member of the staff appointed by the hospital and is not in any sense its employee. In a case of the latter type, it is obvious that the hospital undertakes to procure the physician to treat on his own responsibility, not on the responsibility of the hospital. It is patent that the physician is not acting for the hospital; there is no contract of employment between hospital and physician. The patient, not the hospital, is paying the physician (with the obvious exception of charity cases). The hospital has not selected the patient's physician, nor could it discharge him. The corporation is not benefiting from the activities of the physician in the sense that a middleman or an employer benefits from the activities of an employee.

To facts like these, an official statement by the Board of Trustees of the American Hospital Association may be correctly applied: "The performance of diagnostic and therapeutic procedures by staff members constitutes the practice of medicine *in* hospitals. It is not the practice of medicine *by* hospitals."[41] But, we submit, the same practice by employees of the hospital constitutes the practice of medicine *by* hospitals.

An opinion rendered by Justice Cardoza for the New York Court of Appeals has been the source of no little confusion on this point.[42] In that case the court said, "The relation between a hospital and its physicians is not that of master and servant. The hospital does not undertake to act through them, but merely to procure them to act upon their own responsibility." It is manifest that this reasoning is not applicable where the physician is a full-time employee for whose services the hospital corporation charges and by which it profits. To deny this is to deny the common rules of agency engrafted into our system of law.[43] In finding for the defendant hospital in the instant case, the court relied largely upon the theory granting exemption for tort liability to charitable institutions.[44] Referring to the Schloendorff decision in a later case, the New

[36] 19 A. L. R. 1183; Ark. Midland Ry. Co. v. Pearson, 98 Ark. 399, 135 S. W. 917. ("A physician cannot be regarded as an agent or servant in the usual sense of the term, since he is not and necessarily cannot be directed in diagnosing of diseases and injuries and prescribing treatment therefor, his office being to exercise his best skill and judgment in such matters, without control by those by whom he is called or his fees are paid." This case was quoted by the dissenting justices in Chicago, Rock Island & Pacific Ry. Co. v. Britt, Ark. 74 S. W. (2nd) 398, holding that a contract between a surgeon and a railway company created the relationship of master and servant, and the master became liable for torts committed by the servant in the course of his employment.) Norton V. Hefner, 132 Ark. 18, 198 S. W. 97.

[37] Wolf v. Sulik, 93 Conn. 431, 4 A. L. R. 356. (" . . . the master's liability for the negligence of his servant extends far beyond his actual or possible control over the conduct of the servant.") *Restatement, op. cit.*, Sec. 251. Income Life Ins. Co. v. Mitchell, 168 Tenn. 471, 79 S. W. (2nd) 572. See Mechem, *op. cit.*, Sec. 508.

[38] Jordan v. Touro Infirmary, 123 So. 726.

[39] Runyan v. Goodrum, 147 Ark. 481, 228 S. W. 397. ("Whereas, as we have already shown, the x-ray specialist, or roentgenologist, like the physicians and surgeons, unless he expressly contracts to produce certain results, has the right to, and must at all times, act according to his independent judgment and discretion in the exercise of his skill and learning in the treatment of human diseases . . . . It inevitably follows under the doctrine of our own cases that the relation of master and servant cannot exist between physicians who are not x-ray specialists themselves and the x-ray specialist, or roentgenologist, whom they employ to assist them in the diagnosis and treatment of disease.")

[40] Jenkins v. Charleston Gen. Hosp., *supra*, footnote 33.

[41] See "What is the Issue?" by the author, Illinois M. J., October 1938.

[42] Schloendorff v. N. Y. Hosp. Soc., 211 N. Y. 125, 105 N. E. 92.

[43] Holmes, Oliver Wendell: The Common Law, Boston, Little Brown & Co., 1938, p. 228.

[44] Post, footnote 48.

York Supreme Court said: "It would seem that the decision was not based entirely on the ground that an eminent surgeon was an independent contractor."[45]

While there are many cases on record holding hospitals liable for the negligence of staff members, whether employees or not, the hospital is generally not liable for the acts of those outside its employment. The majority of the cases follow the theory that a hospital is not liable under the doctrine of *respondeat superior* for torts of physicians and nurses who practice on the premises in the independent employ of patients.[46]

There is a line of cases holding that negligent acts of a nature beyond the control of a proprietary hospital do not render it liable as master unless it has negligently chosen the personnel. This is apparently on the independent contractor theory.[47] On the other hand, private hospitals for profit have usually been held subject to the same legal standards of liability as other business corporations, and hence liable under the doctrine of *respondeat superior*, however carefully the staff was selected.[48] Many of the defalcations giving rise to the alleged cause of action for which hospitals have been held liable are clearly professional and due to mistakes in medical judgment made by carefully selected physicians and surgeons who are employed to practise their profession according to their own direction.[49] Such vicarious liability could arise only through the doctrine of principal and agent.

Eleemosynary Institutions.—In what is apparently a conscious intent to cloud the issue, some writers have pointed to the fact that if the employment of a physician creates the master-servant relationship between the physician and his employer, medical schools have long been engaged in the practice of medicine and have occupied the position of a principal by employing physicians. The answer is, of course, that so long as the charging and collecting of a fee is lacking and so long as the institution is not selling the services of its servants for its own profit, the customary principles of agency do not apply, as evidenced by the adjudicated cases.[50] In the case of charity patients, liability on the part of the hospital can be avoided by resort to the implied waiver of liability by a beneficiary, or to the "trust fund" theory that the dissipation of public funds is contrary to public policy. In the case of private paying patients, on the other hand, it would seem that the general rules applying to private hospitals should apply.[51]

MAC F. CAHAL
Executive Secretary,
American College of
Radiology

To be continued

[45] Mills v. Soc. of N. Y. Hosp., 242 App. Div. 245, 274 N. Y. Supp. 233.

[46] Barfield v. South Highlands Infirmary, 191 Ala 533, 68 So. 30 (1915); Simons v. No. Pac. Ry. 94 Mont. 365, 22 Pac. (2nd) 609 (1933); Gosnell v. Sou. Ry. 202 N. C. 234, 162 S. E. 569 (1932); Holland v. Eugene Hosp. 270 Pac. 784 (1928); Pikeville Methodist Hospital v. Donahoo (Ky.) 299 S. W. 159. ("Surgeons on the staff of the hospital are not agents or employees of the hospital.")

[47] Daly's Astoria Sanitorium, 291 N. Y. Supp. 1006.

[48] See 48 Yale L. J. 81 and cases cited there. Mullner v. Evangelischer Diakonneissenverein, 144 (Minn.) 392, 175 N. W. 699 (1920).

[49] See 48 Yale L. J. 83.

[50] In Rivers, *et al.*, v. Atlanta Southern Dental College, 1 S. E. (2nd) 750, the college was enjoined against violating the dental practice act by treating patients in the college clinic and charging a fee therefor. In a number of states the charging of a fee is an essential element in bringing an act within the prohibitions of the medical practice act.

[51] England v. Hospital of the Good Samaritan (Cal.) 88 Pac. (2nd) 727, 97 Pac. (2nd) 813; Sisters of the Sorrowful Mother v. Zeidler (Okla.) 82 Pac. (2nd) 996.

RADIOLOGICAL SOCIETIES IN NORTH AMERICA

Editor's Note.—Will secretaries of societies please cooperate with the Editor by supplying information to keep these notices accurate and up to date? Please send information to Howard P. Doub, M.D., Henry Ford Hospital, Detroit, Mich.

UNITED STATES

CALIFORNIA

California Medical Association, Section on Radiology.—Secretary, Joseph D. Coate, M.D., 434 Thirtieth St., Oakland.

Los Angeles County Medical Association, Radiological Section.—Secretary, Wilbur Bailey, M.D., 2007 Wilshire Blvd.; Meets second Wednesday of each month at County Society Building.

Pacific Roentgen Society.—Secretary-Treasurer, L. Henry Garland, M.D., 450 Sutter St., San Francisco. Society meets annually during annual meeting of the California Medical Association.

San Francisco Radiological Society.—Secretary, J. Maurice Robinson, M.D., University of California Hospital. Meets monthly on third Thursday at 7:45 P.M., for the first six months at Toland Hall (University of California Medical School) and for the second six months at Lane Hall (Stanford University School of Medicine).

COLORADO

Denver Radiological Club.—Secretary, Paul R. Weeks, M.D., 520 Republic Bldg. Meets third Friday of each month at homes of members.

CONNECTICUT

Connecticut State Medical Society, Section on Radiology. —Secretary-Treasurer, Max Climan, M.D., 242 Trumbull St., Hartford. Meetings bimonthly, on second Thursday. Place of meeting selected by Secretary.

FLORIDA

Florida Radiological Society.—Secretary-Treasurer, Elliott M. Hendricks, M.D., 314 Sweet Bldg., Fort Lauderdale. The next meeting will be at the time of the annual meeting of the Medical Association of Florida in the spring.

GEORGIA

Georgia Radiological Society.—Secretary-Treasurer, Robert C. Pendergrass, M.D., Prather Clinic Bldg., Americus. Meetings twice annually, in November and at the annual meeting of the Medical Association of Georgia in the spring.

ILLINOIS

Chicago Roentgen Society.—Secretary, Chester J. Challenger, M.D., 3117 Logan Blvd. The Society meets at the Palmer House on the second Thursday of October, November, January, February, March, and April.

Illinois Radiological Society.—Secretary-Treasurer, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

Illinois State Medical Society, Section on Radiology.— Secretary, Earl E. Barth, M.D., 303 E. Chicago Ave., Chicago.

INDIANA

The Indiana Roentgen Society.—Secretary-Treasurer, Harold C. Ochsner, Methodist Hospital, Indianapolis. Annual meeting in May.

IOWA

The Iowa X-ray Club.—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

KENTUCKY

Kentucky Radiological Society.—Secretary-Treasurer, Joseph C. Bell, M.D., 402 Heyburn Bldg., Louisville. Meeting annually in Louisville, third Sunday afternoon in April.

LOUISIANA

Louisiana Radiological Society.—Secretary-Treasurer, Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society. Next meeting, New Orleans, April 1942.

Shreveport Radiological Club.—Secretary-Treasurer, W. R. Harwell, M.D. Meetings monthly on the second Wednesday, at the offices of the various members.

MARYLAND

Baltimore City Medical Society, Radiological Section.— Secretary, Walter L. Kilby, M.D., 101 W. Read St. Meetings are held the third Tuesday of each month.

MICHIGAN

Detroit X-ray and Radium Society.—Secretary-Treasurer, E. R. Witwer, M.D., Harper Hospital, Detroit. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

Michigan Association of Roentgenologists.—Secretary-Treasurer, J. E. Lofstrom, M.D., St. Mary's Hospital, Detroit. Meetings quarterly by announcement.

MINNESOTA

Minnesota Radiological Society.—Secretary, John P. Medelman, M.D., 572 Lowry Medical Arts Bldg., St. Paul. Meetings quarterly.

MISSOURI

The Kansas City Radiological Society.—Secretary, P. E. Hiebert, M.D., 907 North Seventh St. (Huron Bldg.), Kansas City, Kansas. Meetings last Thursday of each month.

The St. Louis Society of Radiologists.—Secretary, Wilbur K. Mueller, M.D., University Club Bldg. Meets on fourth Wednesday of October, January, March, and May, at a place designated by the president.

NEBRASKA

Nebraska Radiological Society.—Secretary, D. A. Dowell, M.D., 816 Medical Arts Bldg., Omaha. Meetings third Wednesday of each month at 6 P.M. in either Omaha or Lincoln.

NEW ENGLAND

New England Roentgen Ray Society.—(Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island.) *Secretary,* Hugh F. Hare, M.D., Lahey Clinic, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

NEW JERSEY

Radiological Society of New Jersey.—Secretary, H. J. Perlberg, M.D., Trust Co. of New Jersey Bldg., Jersey City. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called by president.

NEW YORK

Associated Radiologists of New York, Inc.—Secretary, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

Brooklyn Roentgen Ray Society.—Secretary-Treasurer, L. J. Taormina, M.D., 1093 Gates Ave. Meetings held the fourth Tuesday of every month, October to April.

Buffalo Radiological Society.—Secretary-Treasurer, Joseph S. Gianfranceschi, M.D., 610 Niagara St. Meetings second Monday evening each month, October to May, inclusive.

Central New York Roentgen Ray Society.—Secretary-Treasurer, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings are held in January, May, and October, as called by Executive Committee.

Long Island Radiological Society.—Secretary, Marcus Wiener, M.D., 1430 48th St., Brooklyn. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

New York Roentgen Society.—Secretary, Paul C. Swenson, M.D., Presbyterian Hospital, New York, N.Y.

Rochester Roentgen-ray Society.—Secretary, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

NORTH CAROLINA

Radiological Society of North Carolina.—Secretary-Treasurer, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meeting with State meeting in May, and meeting in October.

OHIO

Ohio Radiological Society.—Secretary, J. E. McCarthy, M.D., Cincinnati. The next meeting will be held at the time and place of the annual meeting of the Ohio State Medical Association.

Cleveland Radiological Society.—Secretary-Treasurer, J. O. Newton, M.D., 13921 Terrace Road, East Cleveland. Meetings at 6:30 P.M. at the Mid-day Club, in the Union Commerce Bldg., on fourth Monday of each month from October to April, inclusive.

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).—*Secretary-Treasurer,* Justin E. McCarthy, M.D., 707 Race St. Meetings held third Tuesday of each month.

PENNSYLVANIA

Pennsylvania Radiological Society.—Secretary-Treasurer, L. E. Wurster, M.D., 416 Pine St., Williamsport; The Society meets annually; time and place of next meeting will be announced later.

The Philadelphia Roentgen Ray Society.—Secretary, Barton R. Young, M.D., Temple University Hospital, Philadelphia. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22nd St., Philadelphia.

The Pittsburgh Roentgen Society.—Secretary-Treasurer, Harold W. Jacox, M.D., 4800 Friendship Ave., Pittsburgh, Pa. Meetings are held on the second Wednesday of each month at 4:30 P.M., from October to June, at the Pittsburgh Academy of Medicine, 322 N. Craig St.

SOUTH CAROLINA

South Carolina X-ray Society.—Secretary-Treasurer, Malcolm Mosteller, M.D., Columbia Hospital, Columbia. Meetings in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

TENNESSEE

Memphis Roentgen Club.—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

Tennessee Radiological Society.—Secretary-Treasurer, Franklin B. Bogart, M.D., 311 Medical Arts Bldg., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

Texas Radiological Society.—Secretary-Treasurer, L. W. Baird, M.D., Scott and White Hospital, Temple. Meets annually.

VIRGINIA

Virginia Radiological Society.—Secretary, Charles H. Peterson, M.D., 603 Medical Arts Bldg., Roanoke.

WASHINGTON

Washington State Radiological Society.—Secretary-Treasurer, Kenneth J. Holtz, M.D., American Bank Bldg., Seattle. Meetings fourth Monday of each month at College Club, Seattle.

WISCONSIN

Milwaukee, Roentgen Ray Society.—Secretary-Treasurer, Irving I. Cowan, M.D., Mount Sinai Hospital, Milwaukee. Meets monthly on first Friday at the University Club.

Radiological Section of the Wisconsin State Medical Society.—Secretary, Russel F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

University of Wisconsin Radiological Conference.—Secretary, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

CANADA

Section on Radiology, Canadian Medical Association.—Secretary, W. J. Cryderman, M.D., Medical Arts Bldg., Toronto.

Section on Radiology, Ontario Medical Association.—Secretary, W. J. Cryderman, M.D., 474 Glenlake Avenue, Toronto.

Canadian Association of Radiologists.—Honorary Secretary-Treasurer, A. C. Singleton, M.D., Toronto.

La Société Canadienne-Française d'Eléctrologie et de Radiologie Médicales.—General Secretary, Origène Dufresne, M.D., Institut du Radium, Montreal. Meetings are held the third Saturday of each month, generally at the Radium Institute, 4120 East Ontario Street, Montreal; sometimes, at homes of members.

CUBA

Sociedad de Radiología y Fisioterapia de Cuba.—Offices in Hospital Mercedes, Havana. Meetings are held monthly.

ABSTRACTS OF CURRENT LITERATURE

ROENTGEN DIAGNOSIS

The Head and Neck

SCHWARTZ, CHARLES WADSWORTH. Cranial and Intracranial Epidermoidomas, from a Roentgenological Viewpoint 385

PHILLIPS, GILBERT. A Case of Intracranial Aerocele Complicated by Streptococcal Meningitis 385

BRODERS, ALBERT C. Surgical Pathology of the Thyroid Gland 385

The Chest

NEUMANN, WILHELM. Function and Limits of Roentgen Study, Physical Diagnosis, and Laboratory Methods in Recognition of Active Tuberculosis 385

PAINE, JOHN R. Studies in the Experimental Production of Pulmonary Emphysema 386

GOLDMAN, ALFRED, AND STEPHENS, H. BRODIE. Polypoid Bronchial Tumors with Special Reference to Bronchial Adenomas 386

COLE, GEORGE C. The Conus Arteriosus and the Pulmonary Artery: An Improved Method of Visualization 386

GREENEBAUM, J. VICTOR, BROWN, SAMUEL, AND SELKIRK, THEODORE. Roentgen Kymography in the Study of the Heart in Childhood 386

The Digestive Tract

POLLEY, HOWARD F. Congenital Short Esophagus with Thoracic Stomach and Esophageal Hiatus Hernias 387

FRENCH, L. R., AND GARLAND, L. H. Leiomyosarcoma of the Esophagus 387

WHYTE, DAVID. Leiomyoma of the Stomach: A Report of Two Cases 387

The Skeletal System

JAEGER, W. A Study of the Aging of Spinal Fractures 387

RAUBER, A. Perilunar Luxation of the Hand ... 387

JAKOB, F. Osteochondritis Deformans Juvenilis. 388

Obstetrics and Gynecology

KOLBOW, H. Reduction in the Surface Dose by Using Harder Radiation in Roentgen Diagnosis Based on Intravaginal Dose Measurements 388

Technic

HILL, TH. Making of Roentgenogram Reproductions with the Leica 389

RADIOTHERAPY

Malignant Conditions

ADAIR, FRANK E. A Consideration of Recent Additions to Clinical and Experimental Knowledge of Breast Conditions 389

SACHS, MAURICE D. Dangers and Uses of Radium in the Treatment of Carcinoma of the Uterus 390

EXPERIMENTAL STUDIES

ROUS, PEYTON, AND KIDD, JOHN G. Conditional Neoplasms and Sub-threshold Neoplastic States. A Study of the Tar Tumors of Rabbits 390

SYVERTON, J. T., HARVEY, R. A., BERRY, G. P., AND WARREN, S. L. Roentgen Radiation of Papilloma Virus (Shope). Effect of X-rays upon Papillomas on Domestic Rabbits 390

KERST, D. W. Acceleration of Electrons by Magnetic Induction 390

ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Cranial and Intracranial Epidermoidomas, from a Roentgenological Viewpoint. Charles Wadsworth Schwartz. Am. J. Roentgenol. **45:** 18–26, January 1941.

Though epidermoids, with the exception of those found in the middle ear, constitute a very small percentage of cranial tumors—0.6 per cent of Cushing's series of 2,004—there appears to be no cranial or intracranial area which is altogether immune to their occurrence. Jefferson and Smalley (J. Laryng. & Otol. **53:** 417, 1938), to whom the author makes frequent reference, collected from the literature and their own experience 171 cases. The site of election appears to be along the base of the brain and the brain stem, often with extension into the cerebellopontine angle. Something over 12 per cent are intraventricular and about 17 per cent involve the diploe, these latter originating either intra- or extracranially.

Except for the diploic group diagnosis may be difficult, the roentgen signs being usually those common to a number of more usual tumors. The characteristic feature in involvement of the diploe is the presence of a bony ridge around the lesion, sometimes palpable and demonstrable in a tangential film as a dense line passing through the area of bone destruction. Intraventricular dermoids may show a serrated tumor outline, which is highly suggestive of the diagnosis. Epidermoids in the region of the middle ear may occasionally be of a primary nature but most of the tumors so designated are secondary to inflammatory disease.

An epidermoid within a petrous pyramid may be recognized in the roentgenogram by the presence of a localized area of diminished density usually in or near the mastoid antrum and occasionally the mastoid emissary vein will be enlarged as compared to the opposite side. A differential diagnosis between such a lesion and a metastatic tumor would rest almost entirely upon the slow progress of the lesion in one case and the rapidly progressive history in the other.

This paper is illustrated by roentgenograms and includes a comprehensive bibliography.

A Case of Intracranial Aerocele Complicated by Streptococcal Meningitis. Gilbert Phillips. Australian & New Zealand J. Surg. **10:** 83–90, July 1940.

The author presents a most unusual case of posttraumatic aerocele. The patient had fallen in March 1938, striking his head. After about one-half hour of unconsciousness, he arose, had a severe nosebleed, and went home to bed. Here he had a profuse discharge of clear fluid from the right nostril (cerebrospinal fluid rhinorrhea). He suffered from headaches and fever for the next two months and was admitted to the hospital in June.

Except for slight muscular weakness on the right side, there were no positive neurologic findings. X-rays revealed a large subdural collection of air in the left frontal region, 10 × 8 × 7 cm. Because of persistent fever and the spinal fluid findings—616 polymorphonuclear cells and hemolytic streptococci on culture—a diagnosis of streptococcal meningitis was made.

Following prontosil therapy and bed rest, the febrile condition subsided. Serial films showed slow absorption of the air, complete by August 24. During this time the discharge of cerebrospinal fluid slowly decreased.

SIMON POLLACK, M.D.

Surgical Pathology of the Thyroid Gland. Albert C. Broders. West. J. Surg. **48:** 620–632, October 1940.

Broders gives a clear description of the various pathological thyroid enlargements with details of the gross and microscopic features of each type. His classification (slightly modified from that of MacCarty) is as follows:

(1) Colloid goiter.
(2) Non-toxic adenoma: single or multiple colloid and fetal adenomas in a colloid thyroid gland.
(3) Toxic adenoma: single or multiple colloid and fetal adenomas in a colloid thyroid gland with parenchymatous hypertrophy, intra-adenomatous.
(4) Exophthalmic goiter: hypertrophic parenchymatous thyroid gland with or without regenerative hyperplasia.
(5) Exophthalmic goiter with single or multiple colloid and fetal adenomas in a hypertrophic parenchymatous thyroid gland.
(6) Thyroiditis, both fibrous and lymphocytic (including capsulitis).
(7) Specific diseases, including tuberculosis, syphilis, etc.
(8) Malignant neoplasms.

It is of interest that Broders considers most thyroid neoplasms to be adenocarcinomas; many of the so-called sarcomas of the thyroid are highly undifferentiated adenocarcinomas, true sarcomas being very rare. He believes that "benign metastasizing thyroid tumor" is a misnomer and that these lesions are as a rule low-grade adenocarcinomas. Several plates show the histologic appearances of the lesions described.

SIMON POLLACK, M.D.

THE CHEST

Function and Limits of Roentgen Study, Physical Diagnosis, and Laboratory Methods in Recognition of Active Tuberculosis. Wilhelm Neumann. München. med. Wchnschr. **88:** 134–138, Jan. 31, 1941.

The author distinguishes four groups of active tuberculosis: (1) with bronchial dissemination; (2) with hematogenous dissemination; (3) with benign "toxemic" dissemination; (4) with distant neurogenic symptoms throughout the organism from reactivation of old foci.

In the first group lie "open" cases which must be discovered for the protection of others. Here the finding of tubercle bacilli, either in the sputum or gastric washings, is the most important diagnostic indication. A positive sputum without physical signs or roentgenographic changes may occur, especially in primary involvement of the bronchial wall. Roentgenography of the lungs takes second place in importance. It is much to be preferred to fluoroscopy. Physical examination plays a subordinate rôle, as various changes which commonly accompany tuberculosis may mask the signs of even a large cavity. Diabetics should be regularly examined, as they are particularly prone to contract tuberculosis. The combination of a physical examination with roentgenography adds much useful information; this is particularly true of auscultation. For the determination of activity knowledge of the sedimentation rate is essential. This, however, may be affected by other factors than the tuberculosis and the result must be accordingly interpreted.

In the second group of cases the roentgenogram tells the whole story, while the sputum may be negative and physical signs absent. Pleural thickening is common in this type, but occurs also in many other conditions. Enlargement of the spleen below the costal margin is presumptive evidence that dissemination has taken place within the last three months. The febrile reaction is also important in determining activity.

In the third group the author places a number of conditions about which little can be said. These are Hantschmann's torpid sclerosing tuberculosis, Boeck's

sarcoid, Besnier's lupus pernio, Darier-Roussy's sarcoid, v. Jüngling's osteitis fibrosa cystoides, Fränkel's spina ventosa of adults, v. Schaumann's benign lymphogranulomatosis, Mylius-Schürmann's generalized sclerosing large-cell hyperplasia of the liver, spleen, and bone-marrow, Heerfordt's uveoparotid fever, and Mikulicz's disease. These conditions present a characteristic clinical picture and typical histologic structure of epithelioid-cell tubercles with giant cells, completely lacking exudation and caseation; Poncet calls them inflammatory tuberculosis. The clinical features are rather varied, but in all the tuberculin reaction tends to be rather slight, due apparently to a positive anergy. Fever may be absent. The method of choice for determining pleural involvement is percussion. The prognosis is relatively favorable, although the patient may never be restored to full health.

In the fourth group the roentgenogram may show only the old hilar calcification or pleural caps. Physical examination may likewise be negative. This condition is commonest about the fiftieth year. Pleural adhesions and ulcer-like pain in the region of the stomach, duodenum, gallbladder, or appendix are typical. The diagnosis can be reached only by exclusion. The involvement seems to be in the mediastinal portion of the autonomics. Careful study of such cases must be undertaken to avoid a diagnosis of hysteria or neurosis.

LEWIS G. JACOBS, M.D.

Studies in the Experimental Production of Pulmonary Emphysema. John R. Paine. J. Thoracic Surg. **10:** 150–175, December 1940.

The theories advanced to explain the etiology of pulmonary emphysema can be grouped under two general headings: (1) some type of obstruction to respiration; (2) some change in the form or function of the thoracic walls. In studying the first group the author obstructed the tracheas of 10 dogs by means of a special valve which permitted free flow of air into the lungs but greatly hindered the flow of air out of the lungs. Six of these dogs had definite pulmonary emphysema after intervals of four to thirty weeks; 2 died of pneumonia. In 9 other dogs the inspiratory phase of respiration was obstructed by the same valve mechanism placed in a reverse position in the trachea. Six of these showed emphysema.

To affect the thoracic walls the costal cartilages were resected in 4 dogs in an attempt to produce a rigid thorax. This was unsatisfactory since the opposite result was obtained. Seven dogs survived a reefing operation on the diaphragm which caused an enlargement of the thorax. Sixteen to 25 weeks later all of this group showed pulmonary emphysema.

Emphysematous changes in the pulmonary parenchyma occur within four to thirty weeks after partial obstruction to either phase of respiration and in eighteen to twenty-five weeks after the diaphragm has been lowered by a reefing operation. It is possible that any process which increases the size of the thorax for a sufficient length of time will produce pulmonary emphysema.

The literature on the experimental production of pulmonary emphysema is reviewed.

HAROLD O. PETERSON, M.D.

Polypoid Bronchial Tumors with Special Reference to Bronchial Adenomas. Alfred Goldman and H. Brodie Stephens. J. Thoracic Surg. **10:** 327–353, February 1941.

Six to 10 per cent of all bronchial tumors are bronchial adenomas. The authors have reviewed the literature on this subject and have added 18 cases of their own. They believe that these cases represent a definite clinical entity and that they are not low-grade carcinomas but definitely benign tumors. The majority of the patients are women, and 60 per cent have symptoms before the age of forty. In only one known case have metastases been reported. The first symptoms are wheezing, asthma, dry irritating cough, dyspnea, transient chest pains, "choked-up sensations," and respiratory postural discomfort. Later, symptoms of pulmonary suppuration develop, as recurring pneumonia, empyema, abscess, and bronchiectasis. The cardinal symptom at any time is hemorrhage, which is characteristically sudden in onset and termination. Death usually results from suppuration or complications following treatment.

The roentgen picture is one of atelectasis involving varying amounts of the lung depending on the location of the tumor. The tumors are almost always found in the larger bronchi. Rarely an obstructive emphysema is produced. The tumor is not often seen on the plain film but may be demonstrated by tomography, which the authors regard as the most important diagnostic aid since the advent of bronchoscopy. Lipiodol studies may show a smooth, concave obstruction at the site of the endobronchial part of the tumor. Bronchoscopy with biopsy is the best method of arriving at the correct diagnosis.

The histologic diagnosis is not easy and many cases are wrongly called carcinoma, angioma, or inflammatory tissue. Grossly the tumors are usually of dumbbell shape, with part inside the bronchus and part outside.

Radiation therapy has little effect. In a few cases bronchoscopic removal of the tumor will result in a cure. In most cases lobectomy or pneumonectomy is necessary.

HAROLD O. PETERSON, M.D.

The Conus Arteriosus and the Pulmonary Artery: An Improved Method of Visualization. George C. Cole. Am. J. Roentgenol. **45:** 32–40, January 1941.

The technic described by the author for visualization of the conus arteriosus and the pulmonary artery calls for four different positions: postero-anterior, right anterior oblique, lordotic anteroposterior, and lordotic anterior oblique. In the lordotic positions the patient is made to assume extreme lordosis by protrusion of the abdomen while the shoulders are held back. Rotation 20 to 30° in extreme lordosis produces the lordotic oblique position.

The employment of lordotic views offers certain definite advantages over the usual methods of examination. Not only does the conus region appear more sharply demarcated because its greatest length and depth are horizontal to and traversed by the central rays of the tube, but, because the conus is brought forward and rotated on its horizontal axis, the rays are perpendicular to the arc which has the greatest diameter or amplitude; the structures in question being farther away from the screen are exaggerated.

The conus can thus be visualized unfailingly, its size can be measured, and it is better isolated from surrounding structures. The method is especially useful in the diagnosis of doubtful cases of mitral stenosis; it tends to clear up conditions simulating an accentuated conus, and is an aid in the localization of disease processes.

A series of roentgenograms taken in the usual postero-anterior exposure position and in the lordotic position supplement the text.

Roentgen Kymography in the Study of the Heart in Childhood. J. Victor Greenebaum, Samuel Brown, and Theodore Selkirk. Ohio State M. J. **36:** 1194–1197, November 1940.

The authors review the mechanical principles of roentgen kymography and their findings in a group of children. Children below five years of age were not studied because of inability to co-operate. In general, the waves in the normal case resemble those described for adult hearts. In over 100 pathological cases, nu-

merous interesting observations were made. In congenital heart disease, the outstanding finding was the increased amplitude of the pulmonary artery waves. One case of right-sided aorta was discovered as a result of finding an aortic type of wave over what normally should have been the vena cava. Esophageal study with barium confirmed the diagnosis. In acquired heart disease, the findings were similar to those in adults; usually changes are dependent on the relative increase in size of the individual heart chambers.

SIMON POLLACK, M.D.

THE DIGESTIVE TRACT

Congenital Short Esophagus with Thoracic Stomach and Esophageal Hiatus Hernias. Howard F. Polley. J. A. M. A. **116:** 821–825, March 1, 1941.

Akerlund divides esophageal hiatus hernias into three types: (1) congenital short esophagus with partial or complete thoracic stomach; (2)esophageal hiatus hernia with an esophagus of normal length, which does not form part of the hernia (*i.e.*, para-esophageal hernia); (3) esophageal hiatus hernia in which the esophagus is shortened and the distal portion forms a part of the hernial contents. The term "para-esophageal hernia" also defines an esophagus of normal length fixed below the diaphragm with the cardia of the stomach passing upward closely adjacent to it. "Partial thoracic stomach" describes the stomach in association with a congenital short esophagus. Often it is difficult to distinguish accurately one type of hernia from another, even with the aid of laboratory procedures.

A congenital short esophagus with thoracic stomach is regarded as the result of incomplete embryologic development in which the stomach never has been below the diaphragm, usually has no enclosing hernial sac, and is not a true herniation of a once normally placed organ. In esophageal hiatus hernias the herniated stomach constitutes a true hernia with a serous sac and the esophagus also extends below the diaphragm and may or may not extend back into the hiatus. The congenital short esophagus is not so amenable to the usual surgical methods of replacing the stomach into the abdominal cavity as the esophageal hiatus hernia in which the esophagus is of normal length.

In every case, clinical suspicion must be confirmed by laboratory procedures, especially roentgen study. The use of esophagoscopy is advocated as a routine procedure in all suspected cases, especially when surgery is contemplated. Roentgen examination being simpler and less objectionable to the patient than esophagoscopy, it would seem that the latter could be restricted to persons presenting inconclusive x-ray evidence.

In a series of 47 patients with non-traumatic esophageal hiatus hernia, congenital short esophagus with partial or complete thoracic stomach was present in 14. There was a high incidence—48.4 per cent of the series—of co-existing diverticula of the large bowel.

The essentials of medical treatment include weight reduction, dietary regulation, use of antispasmodics and a peptic ulcer régime when indicated, and selective restriction of physical activity.

C. G. SUTHERLAND, M.D.

Leiomyosarcoma of the Esophagus. L. R. French and L. H. Garland. Am. J. Roentgenol. **45:** 27–31, January 1941.

The authors add a fifth to the four previously reported smooth muscle sarcomas of the esophagus. Their patient was a man of seventy with a smooth constriction at the distal end of the esophagus demonstrable roentgenographically, with a moderate dilatation above showing several filling defects believed to represent boluses of food. On esophagoscopy these were shown to be due to the presence of a tumor, diagnosed from a biopsy specimen as carcinoma but proved on autopsy to be a leiomyosarcoma. The tumor was long and polypoid. No metastases were found and there was no extension into adjacent tissues.

A bibliography is appended and photographs of the gross specimen, roentgenograms, and photomicrographs are reproduced.

Leiomyoma of the Stomach: A Report of Two Cases. David Whyte. Australian & New Zealand J. Surg. **10:** 183–188, October 1940.

The author reports two cases of benign leiomyoma of the stomach, both of which were in men in their fifties. The first patient had a history suggestive of ulcer for the preceding eight years but after a severe gastrointestinal hemorrhage was carefully studied. Roentgen examination showed a filled crater high on the greater curvature. At operation, the circumscribed tumor was removed and recovery was uneventful. The pathologic diagnosis was leiomyoma.

The second patient suffered a severe attack of gastrointestinal hemorrhage while at work. He had had no previous dyspepsia or gastro-intestinal symptoms. X-ray examination revealed a filling defect in the pars media and a diagnosis of "polypoid tumor probably not malignant" was made. Gastroscopic examination revealed an ulcerated polypoid tumor on the greater curvature. The tumor was removed surgically and proved to be a leiomyoma. Recovery was uneventful.

SIMON POLLACK, M.D.

THE SKELETAL SYSTEM

A Study of the Aging of Spinal Fractures. W. Jaeger. Schweiz. med. Wchnschr. **71:** 179–181, Feb. 22, 1941.

The rarity of callus formation in spinal fractures deprives us of this method of estimating the age of the injury. It is therefore necessary to employ secondary changes for this purpose.

The stress-lines in the vertebral body, broken at fracture, cannot immediately reform across the break. In minor breaks this requires one year, and in severe ones a year and a half. The sharp gibbus produced by the collapse of a vertebra gradually changes to a smoothly rounded one; this usually takes five months. Lob has shown that a zone of fragmentation appears beneath the end plates of the vertebra after fracture, and this heals by endosteal callus, leaving an area of coarsening of structure. This process requires from six months to a year. This zone of fragmentation is not always to be observed. The compression of the vertebra usually leaves a "step" under the anterior longitudinal ligament which is filled with extravasated material. This eventually ossifies, requiring about nine months to round off the irregularity and about a year and a half to smooth the edges completely. These factors (illustrated by a diagram in the article) enable one to estimate the age of a spinal fracture.

LEWIS G. JACOBS, M.D.

Perilunar Luxation of the Hand. A. Rauber. Schweiz. med. Wchnschr. **71:** 34–38, Jan. 11, and 49–54, Jan. 18, 1941.

Since lunate dislocation is a fairly frequent injury, the author reviewed 44 cases in his own experience, all in men. The mechanism of injury was of two types: 32 patients fell from a greater or lesser height, landing on the outstretched hand; 11 sustained an unexpected blow on the palm, in 4 cases from the "kick" of a motor crank; in 1 case the mechanism of injury was unknown.

Isolated dislocation of the radiocarpal joint is rare,

and may be distinguished clinically from lunar luxation. Carpo-metacarpal dislocation is also rare. The roentgen studies lead to a postulation of the following mechanism for the dislocation of the lunate: (1) The hand is overextended at the intercarpal joint. (2) The capitate is blocked against the dorsum of the radius. (3) The volar (weakest) ligaments between the capitate and lunate tear, and the edges of the bones gape apart. (4) The hand remains fixed by the force of the trauma, and the dorsal edge of the radius wedges between the capitate and lunate, rupturing the dorsal ligament and joint capsule. (5) The radius slips forward with the attached lunate on the capitate. The navicular and triquetrum remain with the capitate. (6) The elasticity and muscle pull draw the carpus proximally. (7) Finally the pressure forces the lunate from its radial attachment.

A reversed dislocation with the lunate on the dorsum of the wrist is an extreme rarity. Lunate dislocation may be simple, or complicated by fracture. In 24 of the 44 cases fracture of the navicular, radial or ulnar styloid, triquetrum, or capitate was observed as an accompanying injury.

The fact that the majority of these dislocations are accompanied by fracture of the navicular or radial or ulnar styloid seems to argue that the force of the blow is on the thenar eminence rather than on the palm. A direct blow on the hand rarely leads to fracture of the navicular. The fact that identical injuries sometimes result in lunate dislocation and sometimes in frank radial fracture suggests predisposition. Shortening of the ulna seems to be a predisposing factor. A "console form" of the radial epiphysis and external rotation of the hand are also predisposing. In 33 of the 44 cases one or more of these factors was present.

The diagnosis is to be thought of in all cases in which trauma to the wrist fails to result in a radial fracture. There is always a painful swelling, which in the final stage of displacement is invariably volar. The ulnar styloid appears as if displaced distally. Especially typical is the position of the hand, in dorsal flexion with the fingers clawed. Median nerve injury is rarely found at the time of trauma, but if the bone is left unreduced it may develop later. Radiographic check may be necessary for diagnosis. The lateral as well as palmar projection is needed. Change in position of the lunate, loss of parallelism with neighboring bones, and a vacancy in the carpal row may be observed. The lateral view is often misinterpreted if only a first stage dislocation has occurred.

Treatment may be by closed reduction, open reduction, or extirpation of the bone. Closed reduction yielded the best results in the author's series when it could be accomplished; extirpation gave the poorest results. Accompanying fracture of the navicular always led to a less favorable result than when the dislocation was uncomplicated. Closed reduction is possible only in the first five to eight days after the injury. Open reduction after this time usually leads to a good functional result and is to be preferred to extirpation. If the bone is left undisturbed in the dislocated position, severe disability, nerve injury, and Sudek's atrophy rapidly ensue. Tenovaginitis is of very frequent occurrence in these cases.

The technic of closed reduction requires direct pull on the hand to relax the muscles. After about ten minutes of this the head of the capitate will snap suddenly into place in cases in the first stage. There may be some persistent rotation of the lunate about its axis. Failure of this maneuver generally implies clot or débris in the bed of the lunate, and calls for open reduction. Roentgen check on the reduction was always undertaken.

Among the late changes observed after this injury are Kienböck's sclerosis, rare after open reduction, and cyst formation. In one of the author's cases an unreduced unextirpated lunate underwent degenerative changes. If the lunate is extirpated, the periosteal tags do not lead to regeneration of the bone. If reduction is obtained, no change in the function of the hand is observed. If reduction is imperfect, arthroses may develop. After extirpation peculiarities of the remaining bones develop as a result of the abnormal articulation. Tenovaginitis, nerve injuries, and injuries to the autonomic system with circulatory changes, cyanosis, and a feeling of coldness occasionally occur.

LEWIS G. JACOBS, M.D.

Osteochondritis Deformans Juvenilis. F. Jakob. Schweiz. med. Wchnschr. **71:** 152–155, Feb. 15, 1941.

The author lists five conditions, Perthes' disease, Köhler's disease, I and II, Osgood-Schlatter's disease, and kyphosis dorsalis adolescentium, as typical examples of osteochondritis deformans juvenilis. In the more unusual types of the disease certain other bones may be affected, as the patella or some of the sesamoids. While these conditions are confined to the growth period, somewhat similar and related conditions in adults are represented by Kienböck's disease of the lunate, osteochondritis dissecans, joint mice, and Madelung's deformity.

Pathologically the condition is characterized by a complete necrosis of an epiphysis. This weakens its internal structure and permits fragmentation to occur as a result of normal stresses. Rarely reparative changes are observed.

Among the etiological factors suggested are acute or chronic trauma and infection, especially chronic, such as tuberculosis, congenital syphilis, or aseptic osteomyelitis, but histological study has failed to substantiate these. Axhausen believes mycotic emboli with sterile infarction to be the cause. Lately growth injury following rickets has been considered. A malfunction of the endocrine system has also been considered (hypogenitalism), but this fails to explain Kienböck's disease and osteochondritis dissecans.

The author feels that there is a physiological kinship between these conditions and the so-called "march fracture" and Looser's "fragmentation zones," in all of which a disorientation of the lamellar structure is observed. Henschen, Haase, and Block think that all these conditions tend to occur in persons who subject the diseased part to chronic and heavy strain. Block (Arch. f. klin. Chir. **174:** 172, 1933) believes, further, that the growing bone subject to such strain is particularly susceptible to a breaking off of the blood supply, especially in the epiphyseal region, and that the changes observed roentgenologically are the result of this ischemia. He calls attention to the frequency of a constitutional insufficiency in children. The author also believes that circulatory injuries account for this condition, and points out that it is observed in locations particularly vulnerable to such a trauma.

While the attempt to assign a single cause to the various conditions mentioned is purely hypothetical, further study of such cases should be sufficient to prove or disprove the idea. LEWIS G. JACOBS, M.D.

OBSTETRICS AND GYNECOLOGY

Reduction in the Surface Dose by Using Harder Radiation in Roentgen Diagnosis Based on Intravaginal Dose Measurements. H. Kolbow. Strahlentherapie **68:** 620–644, 1940.

The doses delivered to the pregnant uterus during a diagnostic exposure should be reduced to a minimum in order to avoid any possible injury to the offspring. The author undertook a series of measurements by means of an integrating dosimeter in a phantom and also in the vagina of patients. Using 85 kv., 3.3 mm. Al filter, 150 ma. and one-quarter of a second, he obtained good views of the pelvis; the dose in the vagina

dropped to 0.05–0.06 r per exposure. By using an intensifying screen the exposure time could be shortened to 0.15 second and the intravaginal dose to 0.03–0.04 r per film. Similar figures are given for exposures of the lateral pelvis or films taken during salpingography and scout films of the pelvis. The doses applied during fluoroscopy of the chest and digestive tract were also determined. A comparison of the doses delivered to the pelvis using the author's technic with corresponding figures available in the literature proved the advantages of the higher kilovoltage in diagnostic work. ERNST A. POHLE, M.D., Ph.D.

TECHNIC

Making of Roentgenogram Reproductions with the Leica. Th. Hill. München. med. Wchnschr. **88:** 127–132, Jan. 31, 1941.

In order to render material available to small hospitals on rare conditions or for the instruction of younger physicians, a method of reproducing clinical records and in particular roentgenograms is desirable. A particularly apt method is the projection of reproductions. The projection of the original films is impractical, and the preparation of a reproduction is simpler and cheaper than the preparation of a direct print. This is especially true of Leica 24 × 36 mm. reductions. A simple camera with standard attachments is all that is needed. Cameras of similar construction (*e.g.*, the Contax) may be substituted. For projection purposes these films are satisfactory and take up little space.

The set-up of the camera requires a glass focusing disk and a measuring rod for object distance. With such thin objects the sharpness of the entire field can be made even by calculated distances for given field sizes. The camera is mounted on a pillar with a base similar to those on enlarging apparatus. The illumination of the object is accomplished with a 4-light box which may be fastened to the pillar. For ordinary use a lens of 5 cm. focal length is sufficient, but for closer work one of 9 cm. is needed. It is also necessary to have a copying apparatus to prepare reversed copies of the reductions. It is essential that the lighting arrangement be good, as over- or underlighting will lead to poor results. Thus with six pieces of equipment, and possibly two extras, one can do this work. In summary, the needed equipment is: (1) a focusing glass with a directed mounting; (2) a development measuring device ("Correxdose"); (3) copying apparatus; (4) photo-electric illumination meter; (5) a good illuminator for both transmitted and reflected light; (6) a projector for miniature film; (7) a long focus objective; (8) an enlarger.

With this apparatus it is possible to turn out 30 or more reproductions an hour. The lens should be open, to allow a short exposure time. While it is possible to vary the illumination, it is easier to make a range of exposures and choose the heavy or light film as desired. Some studies on correct exposure range and reproductions of the resulting films are appended.

LEWIS G. JACOBS, M.D.

RADIOTHERAPY

MALIGNANT CONDITIONS

A Consideration of Recent Additions to Clinical and Experimental Knowledge of Breast Conditions. Frank E. Adair. West. J. Surg. **48:** 645–661, November 1940.

This is an excellent review of the present concept of the pathological physiology of the breast in the light of the newer knowledge of sex hormone action. The survey of technics and results of irradiation therapy in breast cancer is excellent, and the original paper should be read by everyone interested in the subject.

Among precancerous diseases, Adair lists papillary cystadenoma, which is usually considered a benign lesion of the main ducts, often painful and causing bleeding from the involved duct. This is often diagnosed and located by transillumination of the breast as first described by Ewing and Cutler. In a study of 108 cases of bleeding nipple, the author found 47.6 per cent were already cancerous. The second type of precancerous lesion is the "localized mass of hyperplastic or adenomatoid mastitis" which in patients approaching the menopause may often be subject to cellular change and malignant alteration. The fibroadenoma rarely becomes sarcomatous.

The standard treatment for breast cancer is radical mastectomy. In general, the surgical clinics report about 70 per cent five-year cures following radical mastectomy if the disease is limited to the breast. Irradiation in these cases does not alter the statistical result. Once the disease has involved the axilla, however, the five-year cures drop to about 25 per cent with surgery alone. In the hands of more competent radiologists, this figure has been improved to between 40 and 50 per cent (Pfahler and Parry 47 per cent). When supraclavicular nodes are present, radical surgery is contraindicated. Simple mastectomy for carcinoma, with dependence on radiation for cure, is not to be done in any operable case. To quote the author: "My belief is that the advocates of local mastectomy to be followed by irradiation therapy, for breast cancer, have done great harm because they have opened wide the gates for inadequate surgical procedures for the cure of a lethal disease; and have confused many. A number of poorly trained surgeons will not hesitate to perform the local removal of the breast, whereas they would hesitate a long time before attempting the more hazardous radical operation."

One cannot accurately predict the response of any given tumor to radiation from its microscopic and cellular appearance. This is especially true in mammary cancer. The author now uses a divided dose technic, five portals, high total dosage, preoperatively. At first, totals up to 3,000 r units per field were given but the skin reaction was severe and at present dosage is from 1,800 r up. There are cases where mammary cancer can be sterilized by irradiation, as shown by serial section study of breasts preoperatively irradiated. The failure of careful surgery many times is not due to local recurrence but rather to metastatic involvement outside of the breast area that was not recognized at the time of operation.

Preoperative irradiation is indicated in pregnancy; in young women, *i.e.*, between twenty and forty; in all cases with axillary involvement; in diffuse disease, as comedo carcinoma or diffuse duct involvement; in cases with multiple sites of cancer in the same breast; in the presence of skin nodules or skin invasion; in inflammatory cancer confined to the center of the breast. Contraindications are colloid carcinoma, which is radioresistant; advanced age; cardiac disease.

Five-year cures were obtained at the Memorial Hospital in operable cases treated in 1930–34, as follows:

	No Axillary Involvement	Axillary Involvement
Operation alone	68%	25%
Irradiation followed by radical operation	65%	29%
Radical surgery followed by radiation	70%	31%
Irradiation alone	25%	9%

Although one must be careful in radiation therapy

to avoid permanent skin damage and lung fibrosis, adequate dosage must be given. Probably local use of radium or radon may be more effective in clearing up axillary foci of disease, which is relatively hard to treat with x-rays. SIMON POLLACK, M.D.

Dangers and Uses of Radium in the Treatment of Carcinoma of the Uterus. Maurice D. Sachs. Western J. Surg. **48:** 609–615, October 1940.

In discussing the increasing use of radium in treatment of carcinoma of the uterus, the author presents some of the usual technical difficulties encountered and pleads for the use of proper applicators for the anatomical configuration in any particular case. The anatomical relationships of the pelvic structures in cases of carcinoma of the uterus are usually distorted. If improper applicators are used, if they are improperly inserted or poorly packed in position, the usual result is inadequate irradiation of tumor tissue and necrosis of normal mucosa. X-ray films on a number of patients showed spontaneous displacement of even carefully inserted radium applicators. The author prefers the London type cervical bomb to the dumbbell colpostat.

SIMON POLLACK, M.D.

EXPERIMENTAL STUDIES

Conditional Neoplasms and Subthreshold Neoplastic States. A Study of the Tar Tumors of Rabbits. Peyton Rous and John G. Kidd. J. Exper. Med. **73:** 365–388, March 1941.

The authors discuss tumors elicited in the skin of a rabbit with tar, classifying these growths as papillomas, carcinomatoids, and frill horns. The results following continuous tarring are compared to repeated intermittent tarring. The repeated intermittent tarring calls forth warts in greater and greater profusion and the growths occur earlier. Non-carcinogenic stimuli such as wound healing and turpentining provoke recurrences. Considerable space is devoted to discussing the somatic mutation and virus hypotheses.

The authors conclude from this study that the "warts" such as are elicited in the rabbit skin from tar are true tumors, benign growths expressive of slight yet irreversible deviations of epithelial cells from the normal. This neoplastic condition gives the cells a superiority over their neighbors when both are submitted to the same encouraging influences. Such a state also entails some disabilities in that the cells are unable to maintain themselves under ordinary circumstances and consequently growths composed of them disappear when no longer aided. Frequently the neoplastic cells resume the normal aspect and habit of life long before the tumor is gone and they may persist as part of an apparently normal epidermis, retaining their neoplastic potentialities for months after all signs of the growth have disappeared. The deviations from the normal represented by the benign tar tumors of rabbits are slight and limited in character. However, further deviations in larger varieties may be superimposed upon them, resulting in malignant tumors. Tar cancers usually come about in this way, by successive, step-like deviations from the normal, as do also cancers which are derived from virus-induced papillomas, as well as many human carcinomas. After cells have become cancerous, they frequently undergo further changes, some apparently step-like in character, and all taking the direction of greater malignancy. ANDREW H. DOWDY, M.D.

Roentgen Radiation of Papilloma Virus (Shope). Effect of X-rays upon Papillomas on Domestic Rabbits. J. T. Syverton, R. A. Harvey, G. P. Berry, and S. L. Warren. J. Exper. Med. **73:** 243–248, February 1941.

Papilloma occurs in nature in the cottontail rabbit, the result of a specific virus. Transmission to domestic rabbits is possible by inoculation with virus obtained from such papillomas. In both the cottontail and the domestic rabbit the papilloma is benign in its onset but undergoes alterations and becomes a malignant epidermoid carcinoma.

The authors obtained a virus from papillomas present on cottontail rabbits and inoculated the inner aspect of the distal half of each ear of 62 domestic rabbits. Roentgen irradiation was instituted 29 to 192 days after the inoculation (technical factors: 200 kv., 25 ma., 0.5 mm. Cu + 1.0 mm. Al filtration). The target skin distance was 30 cm. from the target to the base of the tumor. Irradiation was applied to the inner aspect of the ear, at the site of the lesion.

The 62 rabbits were divided into three groups. The first, or preliminary group, was given single graded doses varying from 250 to 2,000 r. In this group, the papilloma was not eradicated in any of the animals receiving less than 2,000 r and of the 6 rabbits receiving such dosage, in only one did the papilloma disappear. In the second group the animals received massive single doses varying from 2,500 to 5,000 r. Here it was noted that the papillomas disappeared in 60 per cent of those receiving a single dose of 3,000 r, and in 100 per cent of those receiving 3,500 r or more. In the third group the animals received daily fractional doses of 600 r each, with the total dose ranging from 2,400 to 6,000 r. In this group 53 per cent cures were obtained when the total dose reached 3,000 r, and in those animals receiving a total fractional dose of 3,600 r or more there were 100 per cent cures.

The authors conclude that within the limitations under which the experiment was conducted the virus-induced papilloma of Shope responded approximately to the same total dose regardless of whether it was given in the single massive treatment or by the fractional method. In a previous experiment it was found that it required 14 million r to render non-infectious a cell-free suspension of the papilloma virus, when irradiated *in vitro*. It seems evident, therefore, that the effective elimination of papillomas from domestic rabbits by roentgen therapy is not due to a direct action of the roentgen rays upon the papilloma virus *per se*, but rather indirectly through influence on the host's tissues.

ANDREW H. DOWDY, M.D.

Acceleration of Electrons by Magnetic Induction. D. W. Kerst. Physical Rev. **58:** 841, November 1940.

The electromotive force in an A.C. transformer which makes a current flow in coils can also accelerate electrons. In a magnetic field the electrons could be held to circular paths. If the acceleration made the electrons speed up in a degree equal to the amount of increase in the magnetic field which was holding it to a circular path, then this circular path could be held of constant diameter. This was accomplished successfully with an 8-inch magnet at 600 cycles. The entire acceleration takes place in one-quarter cycle. By a distortion in the magnetic field it was possible to make the end of the path turn off a bit and hit a target. The total length of the electron path was about 100 kilometers, yet a vacuum of a millionth of a millimeter of mercury was found to be low enough pressure. The x-rays produced indicated an energy of two and one-third million volts, but the intensity was very small indeed, amounting to the gamma rays from 10 mg. of radium. R. R. NEWELL, M.D.